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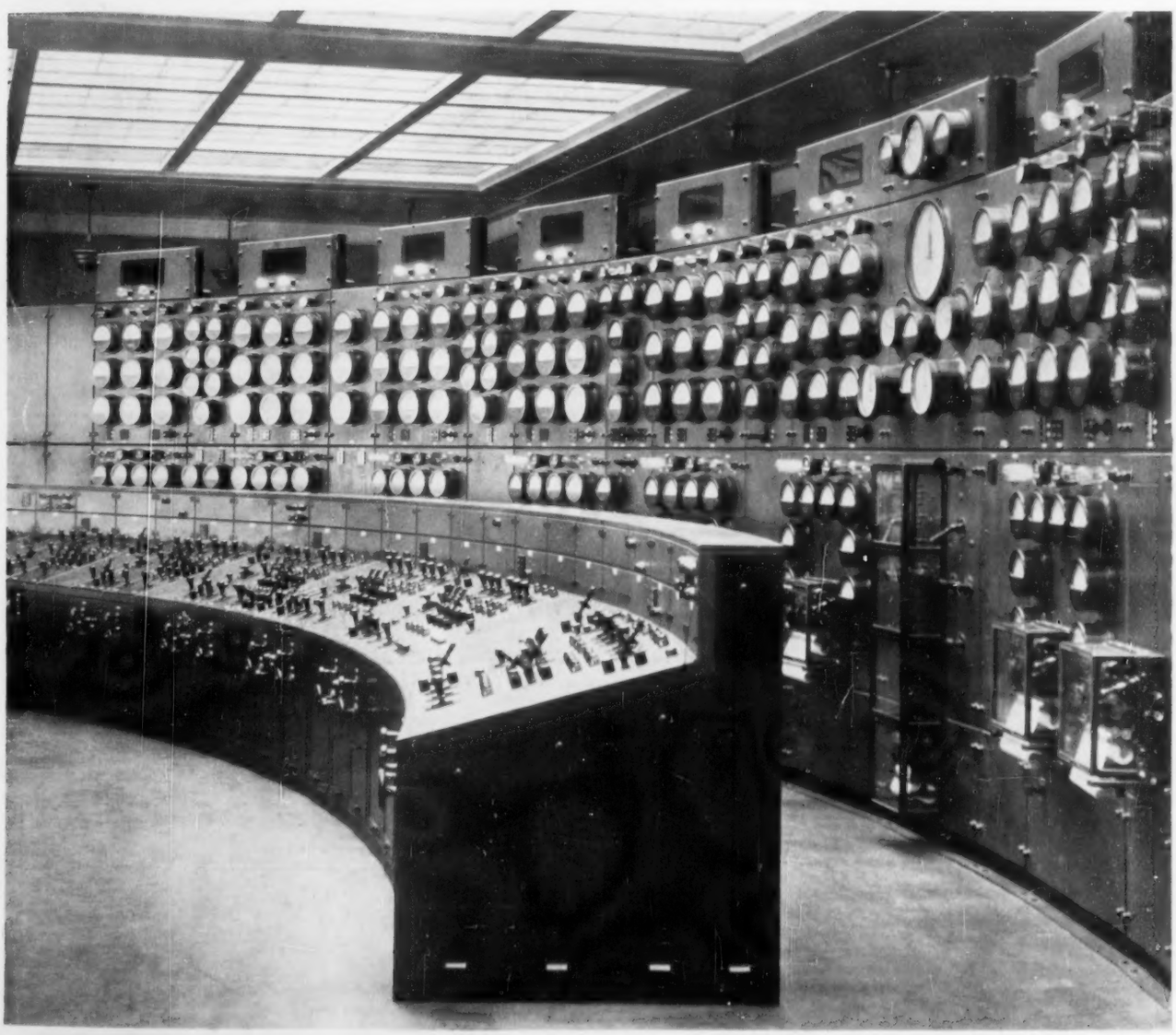
VOLUME 5 JANUARY, 1932 NUMBER 1



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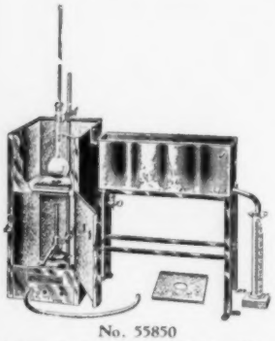

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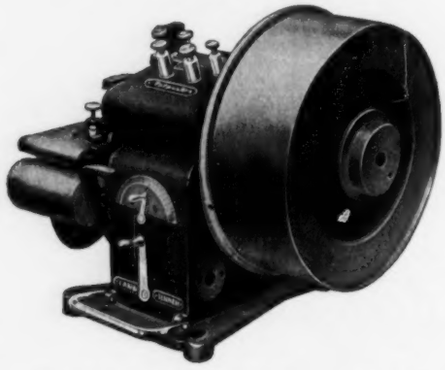

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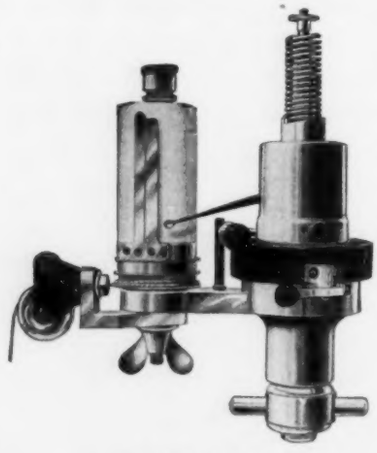

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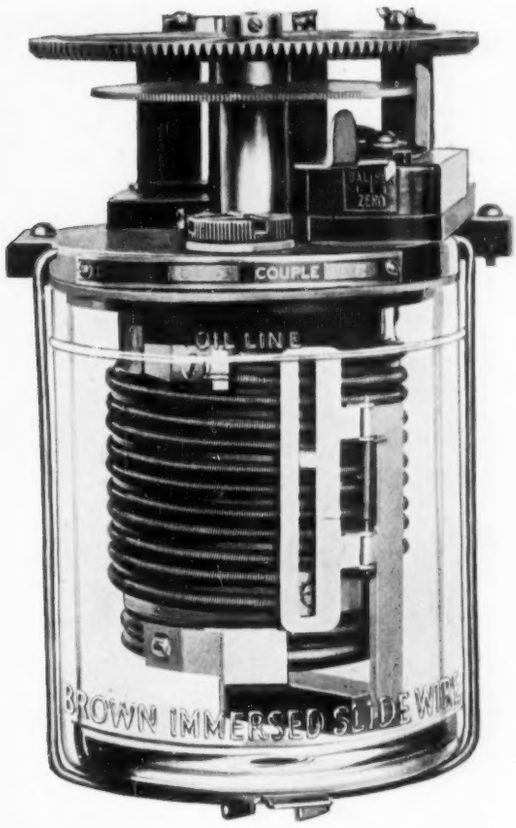

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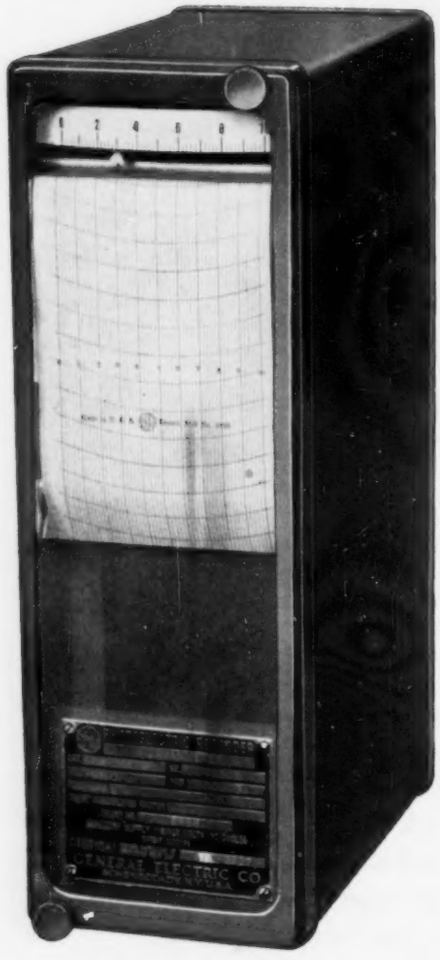

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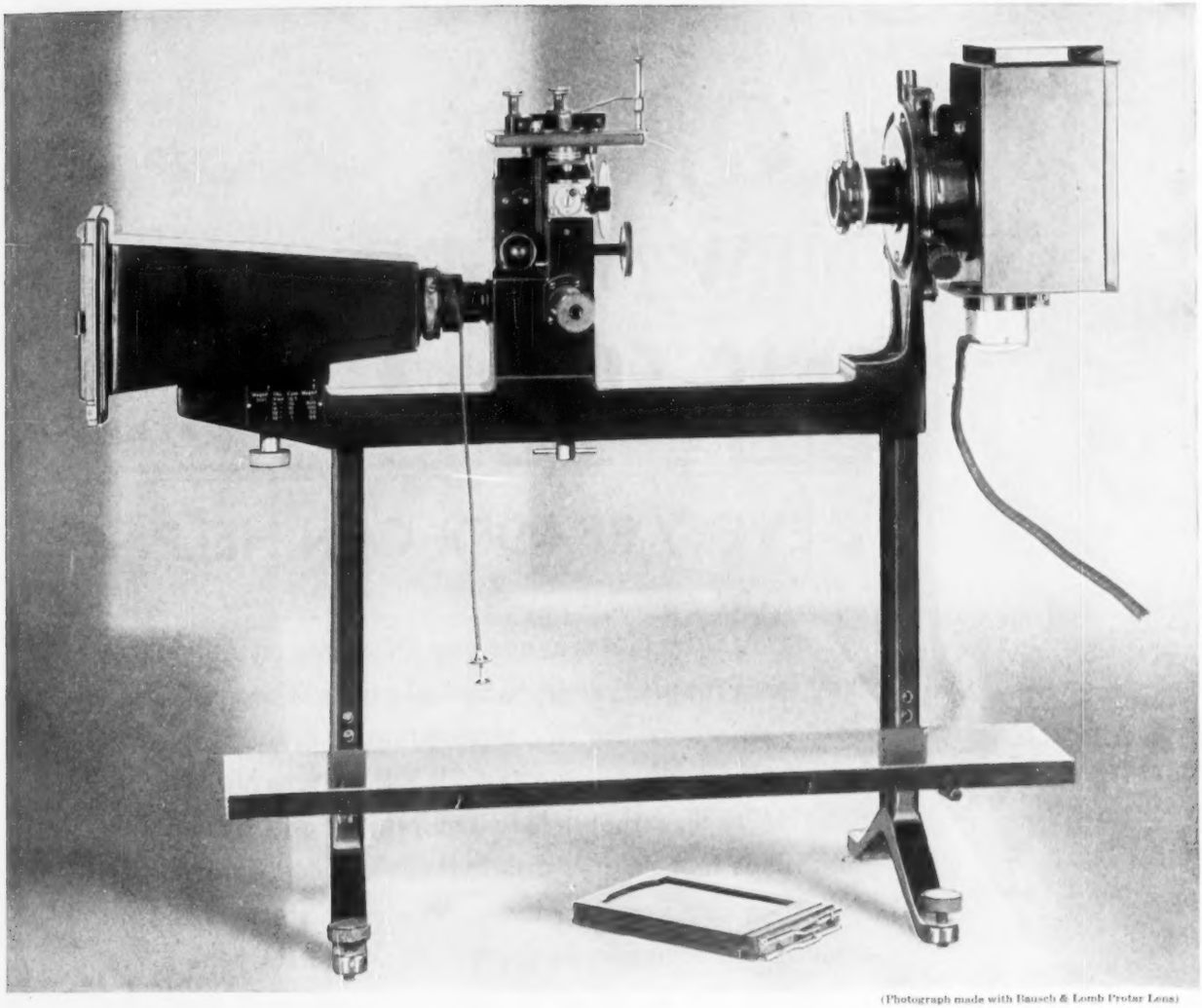

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1932 promises to be our most active, most progressive year. INSTRUMENTS goes to a larger size, extends its scope to include the industrial application of electronic devices, and increases its new instrument section as well as its abstract service. Our increased activities will progress greatly if the number of our subscribers is greatly increased. INSTRUMENTS therefore asks the help of each reader to do his best and obtain four new subscribers.

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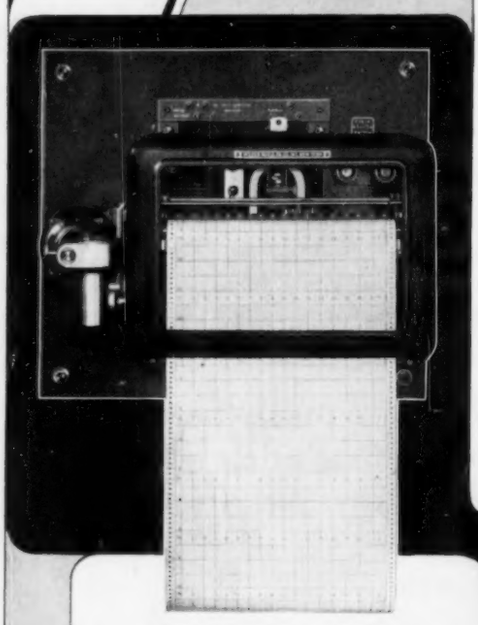

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EDITORIAL COMMENT

The Meter Reads 48

WITH the December issue INSTRUMENTS completed its 48th month of service to the users and manufacturers of instruments and devices for measurement and control. We have striven to make this service a useful one.

Founded four years ago, INSTRUMENTS enters the new year with the same name, a new size and an enlarged editorial staff. All this permits serving our readers better.

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Enter, Subject Electronics

ELECTRONICS was a word unknown but a few years ago, yet in that short time it has not only been adopted, but has gained tremendous significance. A few years ago it signified tedious and costly scientific researches, those of Thomson, Richardson, Langmiur, Bohr, Schottky, Dushman and others. Since then, it has come to mean in addition, new methods in science and industry, new industrial processes, even new arts (broadcasting), and new industries (talkies, radio).

For measurement, both industrial and scientific; for inspection and for control, the subject "electronics" means new developments that bring great changes and vast possibilities. INSTRUMENTS recognizes the consequent importance which matters coming under the subject of "electronics" have for those engaged in measurement, inspection, and control. Accordingly, INSTRUMENTS has extended its scope to include electronic subjects of interest to its readers.

The editorial personnel has been increased to include an engineering editor well qualified to treat electronic matters. (A sketch of Mr. Olken's background and qualifications will be found in this issue.)

Furthermore, the following items on electronics are planned for future issues of INSTRUMENTS.

1. Reviews of electronic developments in measurement, testing, and control in the recent past. A review of photoelectric developments already appears in the present issue. Following issues will review radio developments in instrumentation, then instrumentation developments using standard radio tubes; finally those developments arising from new, or special, electronic devices.
2. Wider and more complete abstracting service, under new classification headings, with a special heading for "Electronics and Radio."
3. Appropriate and timely articles on current progress in electronic applications to instrumentation.
4. A series of articles constituting a handbook on electron-tubes, their characteristics, and their applications to measurement, testing, and control.

With this enlarged service on electronic subjects INSTRUMENTS makes another stride forward in its aim of bringing the advances in the field of instrumentation to help promote accuracy and efficiency in industry.

You and The Editor

THE reader and the editor of a technical magazine such as INSTRUMENTS may be unknown to each other, yet they are very closely connected. The reader seeks to learn and benefit by the advances in his field of industry. For that reason he follows his chosen technical magazine. The editor aims to benefit his reader, so you and the editor both strive toward a common interest.

Much is gained by the reader in seeing things with the eyes of the editor. He sees things in the pages of the magazines as if he were, like the editor, in close and active touch with whole industries and the people engaged in them. To the editor it would be immense benefit if he could see with the eyes of the reader. So co-operate in your common interest with him—*write to the editor.*

Let him see in the pages of your letter the magazine as you see it. If there is something you do not like, or do not believe, or perhaps do not understand, write to the editor. Tell him all about it. In clearing up the matter he may uncover something important which is obvious when close at hand, but at the reader's distance is obscure. This may be of considerable help to other readers as well. To the editor your constructive criticism will be helpful for future guidance, and will be received with friendly appreciation.

Should you miss something in INSTRUMENTS that you feel ought to be there, the editor would like to hear from you about it. Perhaps other readers feel the same lack, then the editor will be pleased to have learned what is required of the magazine, and do his best to fill the requirement. If it is a matter in which you personally want a wider background, the editor feels at all times ready to call on all his facilities or connections and satisfy your inquiry to the fullest.

If you know anything new or more advanced about material in the magazine, write to the editor. Make your contribution on the matter to him. He will not only be thankful for your aid in widening his scope on the subject, but will gladly extend your contribution to his readers, giving due credit where credit is due.

When you like anything in INSTRUMENTS, or you are pleased with the way something is treated in the magazine—by all means, write to the editor. What's more, the knowledge that he is running the magazine in the direction which fills the need as outlined by the readers will assure him of being on the right course—an assurance he always appreciates.

With this issue INSTRUMENTS grows to larger size and increased scope. This alone will excite in you many ideas and opinions. Don't hoard them. Ideas, like dollars, produce results only when in circulation.

Circulate your thoughts so as to advance the interest you have in common with the editor. Let him see things with the eyes of the reader. Whatever your ideas, opinions, or criticisms be—favorable or unfavorable—make them a source of mutual benefit between you and the editor. WRITE TO THE EDITOR.

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A New Measurement Manual

THE basis of all technical progress is observation and measurement. Whether in scientific research or in supervising plant operations, quantity and quality must be determined each day. Measurement must be made to furnish the fundamentals for economy and progress.

The engineer, plant manager, or scientific worker must have the latest information, the latest status of development on a problem in his own sphere, to get the best solution for that problem. He wants to know which is the best apparatus and device to use. He must know its properties and characteristics to sesure the best operation of the apparatus used.

Where will he find this information in up-to-the-minute, complete, authoritative form? Searching through books gives him only random fragments, takes much time, and provides information that was up-to-date only when the book was written.

The Archiv für Technisches Messen is a new publication brought out to fill this need. The purpose of this manual is to gather the material currently published in the field of technical measurement. The collected material is organized and adapted so the user can get directly at what he wants, and find a thorough, complete, authoritative treatment of the latest technique or developments in the subject.

The manual will comprise a series of about sixty reports brought out in the course of five years. Each report will contain a number of summaries each of which will be a complete theoretical and practical treatment of one subject, by an authority on that subject. The reports are decimally classified, alphabetically indexed, and come on forms ready for loose-leaf filing. Any subject can therefore be found quickly and easily. Each report is dated, and in fields where progress is rapid timely revisions will be published with the latest information, thereby keeping the manual completely and constantly up to date.

The Archiv, published in German, is edited by Dr. Ing. George Keinath, Honorary Professor for Electrical Measurement, Technische Hochschule Berlin, author of "Elektrische Temperature Messgeräte" and "Die Technik Elektrische Messgeräte." Twelve reports will appear each year. Each report contains 32 pages of text, exclusive of supplementary matter. Size of sheets is 8 x 11 inches. Subscription price per year is $5.00.

The March of Progress in Photo-Electricity

ELECTRONIC developments in the past year came thick and fast. To the industrial user of electronic devices one branch in this surge of progress stands out as particularly noticeable—the developments in the photo-electric field.

Photo-electric cells entered the year as items of practical application, yet still faint and frail: faint, because the light-produced voltage, current, or resistance variations of even practical photo-electric cells were of microscopic order: frail, because the power handling capacity too, of most cells, was microscopic in magnitude.

Progress during the year, however, saw the faint and frail photocell grow powerful and rugged. A new selenium cell of high sensitivity and comparatively large current carrying capacity was developed and put on the market. There even came into commercial production a cell which, under ordinary daylight illumination, generates a voltage powerful enough to operate a relay directly.

These developments bring the photocell to a stage of highly practical usefulness. Increasing application of the photocell to measurement by light, inspection by light, and light control are therefore in order. Consequently the future in this field should be interesting and very fruitful with developments.

INSTRUMENTS will study the future closely for these developments in photo-electric applications to measurement, testing, and control, and will convey to its readers the latest and best information of progress in this field. In addition, as a background for better understanding of progress in the future, we present in this issue a review of the developments in photo-electronics during the year just past.

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Introducing Our New Editor

H. Olken obtained the degrees of Bachelor of Arts and Master of Arts from Harvard University, specializing in Physics. His graduate work was devoted principally to electronics. The practical application of this education was made in the engineering department of the Union Switch & Signal Company, Pittsburgh, at the Hygrade Lamp Company, Salem, Mass., and at the Atlantic Precision Instrument Company, Boston. This experience covers both the development and application of electronic measurement and control in industry.

Mr. Olken is a member of the Institute of Radio Engineers.

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Announcement is made by R. Fuess, Inc., instrument manufacturers of Berlin, Germany, that they have established a New York office at 245 West 55th Street. The concern has been established for many years, developing a wide, comprehensive line of instruments for scientific and industrial research which now includes the following fields: meteorological instruments; testing apparatus; measuring apparatus for pressure, temperature and humidity; thermo-control instruments for measuring flow, pressure; microscopes and general optical instruments; spectroscopic apparatus; and special apparatus made to specification.

Photo-Electric Developments in 1931

By H. OLKEN*

FOR A bird's eye view of progress along photo-electric lines during the past year, we may divide our review into two parts. First, we note the advances in photo-electric cells. In the second part, developments in the applications of photocells to measurement and control come up for consideration.

PHOTO-ELECTRIC CELLS

This year's progress in photocells was distinctly different from the general trend in recent years, in that refinements and modifications of photo-emission cells were not the most prominent advances made. Instead, the notable developments were in photo-resistance and photo-voltaic cells.

Considering first photo-emission cells (i. e. those in which light causes emission of electrons), the only considerable advances were: Increased leakage resistance, obtained by covering the leads inside the cell with glass sleeves.[1] The higher leakage resistance so obtained aids considerably in increasing amplification of the photo-currents by vacuum tube amplifiers. Quartz-window cells were also developed for greater ultra-violet sensitivity,[1] to better meet the needs in biological work.

Methods for securing greater response to light variations in photo-emission cells were aimed at, particularly through the agency of secondary emission.[2] As yet no notable commercial device along these lines has been announced.

Cells in which light produces a change of resistance made a very considerable advance with the development of a so-called selenium "bridge."[3] This photo-electric cell is an improvement over selenium cells of the past in the following ways:

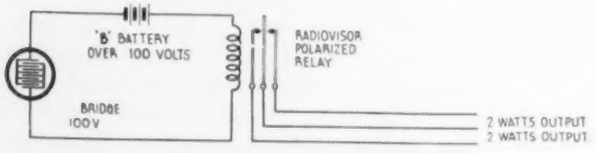
First and most important, it has greatly increased sensitivity. Under a change of illumination from dark to 10 foot-candles with 135 volts d.c. on the cell, its current increases about 250 microamperes.[4] This is not only a great increase over earlier selenium cells—an increase of about 200 microamperes for the same change in illumination, but is an even greater response than is obtainable with other types of photo-electric cells, particularly the photo-emission cells.

Construction features of this new selenium bridge also present many advances. One notable construction feature is that the cell has been made electrically and mechanically rugged.[5] The improved construction also reduces disturbing factors such as fatigue and lag to negligible values for most practical purposes. Also, due to the improved construction, current-carrying capacity of the "bridge" is made comparatively very large (it can dissipate about 0.15 watts continuously)—so that with a battery of high enough voltage to provide such a current, the "bridge" can control a sturdy relay directly, in response to light changes.

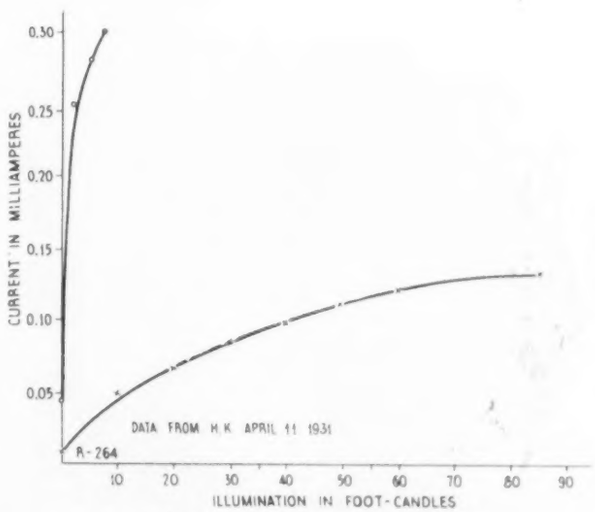
There remain to be considered developments in photo-voltaic cells (those which generate a voltage when acted on by light). One cell recently developed[6] generates enough voltage under ordinary daylight to operate a sensitive relay.

Interesting as new features are the following characteristics[7] of the cell: In the first place the cell element is dry, not containing fluid chemicals with consequent danger of spilling, as in earlier photo-voltaic cells. Further, the great sensitivity of the cell makes possible its use without elaborate amplifying apparatus. Above all, since the cell generates a voltage in response to light, it can be used even without batteries to actuate a meter or a relay. The great value of this feature is that it makes possible reducing illumination measurement to the utmost possible simplicity—just a cell responsive to light intensities, and an indicating meter actuated by these responses—what could be simpler?

Before 1931 photo-electric developments were confined in large part to refining the old developments. There was a veritable stampede in the direction of improving photo-emission cells, but photo-resistance and photo-voltaic cells received little attention. The great emphasis of development lately on these cells



Simple Circuit for Operating Relay by Light-Response of new Selenium Bridge.



Comparative Current-Sensitivities Top Curve—New Selenium Bridge Lower Curve—Old Selenium Cell.

*Engineering Editor, INSTRUMENTS.

can be taken to indicate that development trends in photo-electricity are towards realizing the possibilities of obscure but promising fields, rather than carrying to the utmost the possibilities of well-developed lines. If this speculation is at all correct, then we may expect in the future more basic photo-electric developments than mere refinements of existing devices.

In that case, one development that may reasonably be expected to follow in the near future is a position-sensitive photocell; that is, a photo-electric cell whose current will vary with, let us say, the distance from the base of the cell at which the light beam is received. Thus a photocell receiving a beam of light from the pointer of a meter would change its current with different positions of the pointer, for as the pointer moved over the scale, the beam would enter the cell at different positions from its base. In amplifying and transmitting indications of motion, particularly for remote metering, such a cell would find vast fields of application.

Granted that applications of photocells to indicate motions have been made— a good example is a photo-electric recorder,[8] in which motions of a meter's indicating element are indicated on a recorder chart through the agency of photo-electric cells—still, by using photocells sensitive to intensity, rather than to position of the incident light beam, it is possible to get photo-electric indications of motion only by round-about methods.

Perhaps such position-sensitive cells are available, but are as yet unannounced. At any rate, it is felt that at the present stage of the art and science of photo-electricity such a cell, responsive to the position at which a beam of light reaches it, is well within the field of possibility.

APPLICATIONS

Progress in applications of photocells to measurement and control, though not spectacular, was highly significant. Basic lines of application were entered upon. This fact bears the great significance that, though developments in the new lines of application have far to go before reaching perfection, wide fields for development of photocell applications have been opened up.

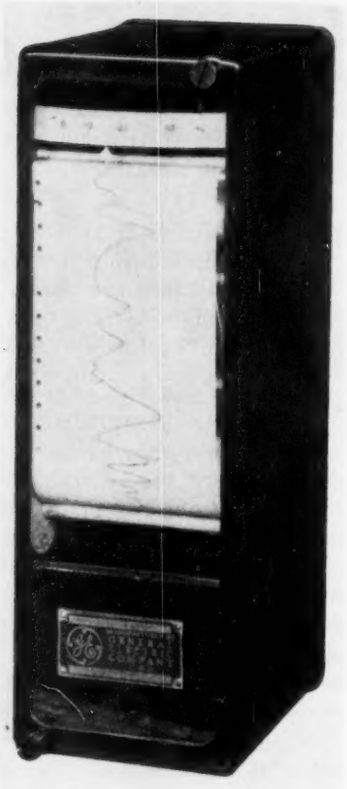


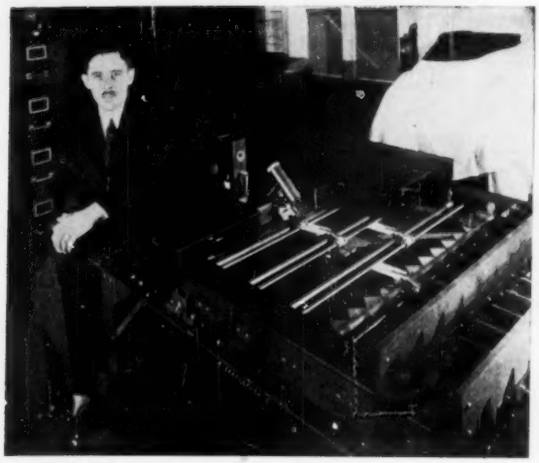
Photo-Electric Recorder.

Voltage-Generating Photocell.

Instrument Applications

Looking first into applications of photocells to instruments, we find two basically new lines of development. To begin with, there is an illumination meter[9] consisting of two photocells with a meter to read their output. This brings illumination measurement down to the simplest and most fundamental basis—a light sensitive element, and a meter to indicate the response of that element to light. Auxiliary amplifiers and power supplies are done away with. How the performance of this device compares with more elaborate amplifier-using photocell set-ups for measuring illumination, we have yet been unable to learn. But we do feel that this device has definitely turned illuminometry development toward the simplest possible arrangement—that of a light-responsive device acting directly on a response-indicating instrument.

Next in photo-electric applications to instruments is a photo-electric recorder developed during 1931. In this device[10] a beam of light serves as the meter pointer, the beam being reflected from a mirror on the moving element of the meter. The motion of this light beam is followed up and recorded by a photo-electric cell arrangement. This is a radical departure from the present practice in recorders, which is to clamp the meter pointer for an instant, then, while clamped, depress it against a type ribbon. Below this typing ribbon is a chart paper upon which is left an imprint when the ribbon is struck by depressing the pointer.



"Code" Card Sorting Machine

Features new and different brought forth here are: First, the burden on the moving meter element due to clamping the pointer is eliminated. Second, the moving element uses a light beam for pointer, and so can be made lighter and less rugged, thereby producing a more sensitive instrument. Finally, and of greatest importance, the meter pointer, really a light beam, is followed up by a mechanism capable of exerting any desired amount of power for recording or controlling purposes, without in any way burdening the meter's moving element. The advantage here is that, no matter how delicate and sensitive a moving element is used, it can operate as rugged and powerful a control as desired.

Here again, as for the new illuminometer, there is lacking the extensive experience with this device required for a performance comparison with present recorders. However, we are distinctly impressed by the appearance of this photo-electric recorder that recorder development has turned the corner toward the ideal of unlimited meter-sensitivity, combined with unlimited power for recording or controlling in the wake of the meter indication.

Control Applications

Last in our review, although far from least in importance, we come to progress during 1931 in control applications of photo-electric cells. The most conspicuous development in this direction was the emergence of the photo-electric "light-relay" as a complete unit, and a standard item of industry.

This seems to be the result of a fast growing "light-relay" consciousness. Operators of plants and industries are becoming so aware of the functions in their plants that can be performed by a light-actuated relay, that at least half a dozen companies[11] have come out with photo-electric relays, in standard units, complete and ready to install.

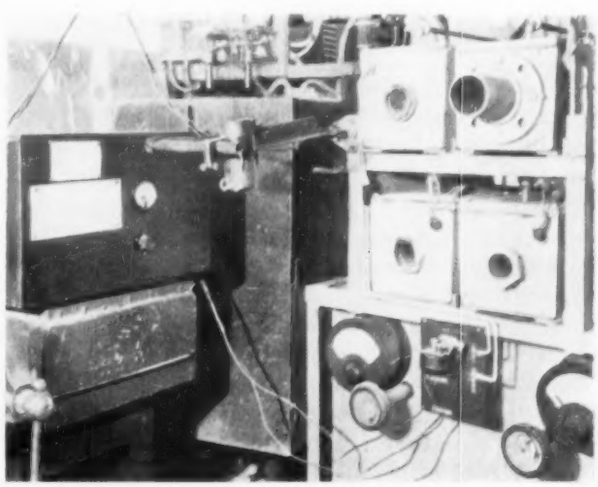
There are two functions for which relay action by light is ideally suited. First is the case where we wish to indicate the motion of a body without disturbing that motion. For example, when a scale is being balanced, suppose we wish a lamp to light when the beam reaches balance. A switch must be operated to light the bulb, but for the beam to operate the switch, no matter how sensitive a switch, would disturb the weighing. What could be simpler, then, than to have the scale beam, when in balance position, interrupt a beam of light reaching a photo-electric cell? Shutting off the light will produce a great change in the photocell current. This change of current can operate a relay to light the lamp. Scales thus controlled by light-relays are already commercially available.[12]

The other function of which relay action by light is ideally suited occurs where objects must be counted or sorted without being touched by the counting or sorting device. For instance, to count freshly painted objects moving on a conveyor, no mechanical counter will do, as it would have to touch the objects, and in doing so might spoil the coat of paint. But if the painted objects each interrupt a light beam, which interruption operates a counter, they can all be counted without harm to the coat of paint.

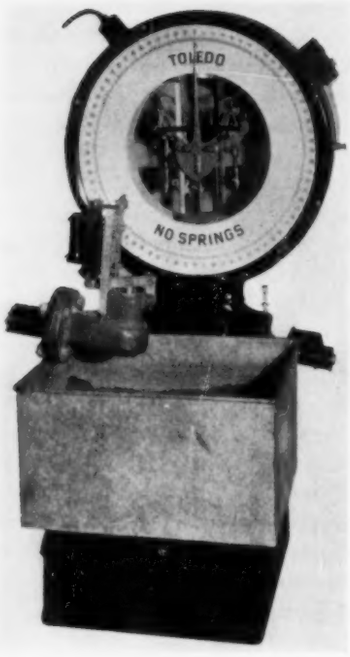
Besides photo-electric instruments and light-relays, great fields of application for photocells exist, in which notable advances were made during the past year.

The field in which changes of light intensity operate to measure or control has been so far developed, that amplifiers to amplify the current variations of photocells have become standard equipment with several manufacturers.[13] Color-matching and analysis is one of the most general applications for which this apparatus is useful. Complete machines for this work are already commercially available.[14] Control of illumination, that is, turning lights on or off automatically to provide best illumination in offices or plants, is another application of control by amplified photo-electric cell responses, for which standard units[15] have been announced commercially.

Of greater significance for the future course of industrial control progress are two applications developed last year. One is for the control of furnace temperature by photo-electric measurement of radia-



Temperature Control of Furnaces (Boxes on right) by Photocell (in tube, at center of picture)



Photocell Controlled Automatic Scale.

tion from the furnace. Another is what may be termed "code control."

The application for regulating furnace temperature was developed by Dr. Koller of the General Electric Co.[16] Although this application is not perfected, yet the features which photo-electric furnace regulation makes available are already apparent. They are:

1. Control can be extremely sensitive, instantaneous, and continuous,; all because radiation from a hot body changes much faster than its temperature, and photo-electric cells respond instantly, continuously, to changes of light intensity.

2. Control can have unlimited flexibility, because changes of sensitivity can be made by simple electrical adjustments, and the mode of control—holding to a fixed temperature, a definite maximum temperature, or a fixed minimum temperature, can be varied by changing just the control circuit arrangements, without disturbing the temperature responsive element.

3. Finally, the sensitive element activating the control apparatus is outside the furnace, therefore free from deterioration by the process being controlled.

How soon all these features will be available in the form of a commercial photo-electric temperature regulator, only the future can tell. But such a control has been demonstrated as practical, so "it won't be long now."

Another photo-electric cell application made last year which is more of interest with regard to the future than the present, is what may be called "Code Control." A machine was developed which sorted cards into different compartments according to a "code" of lines printed on the cards.[17] The sorting was done by the action, through relays, of a photocell's response to the spacing of the code lines on the card. The principle of this machine has great significance for industrial control use. If we can write in code on a card, and can arrange a photo-electric cell to convert the code statement into a control function, then a great new field of industrial control by code is thrown open. For example, suppose a beef inspector at an abatoir inspects a long line of carcasses on a conveyor, and jots down on a card in code the classification to which each carcass shall be assorted. Then he puts the card into a photo-electric "code controller," and the carcasses are routed automatically to their appropriate destinations.

Considering developments of the past for their bearing on the future may seem visionary, but at the rate developments are being applied today the "vision" of this year is the practice of next year. Light-relays, for example, were regarded as merely a laboratory toy in 1930 when the common question was, "Well, what if it does control by interrupting a beam of light—what is there to be controlled by it?" Yet in the year just past the light-relay became a standard and universal industrial item. The "vision" of but a year ago finds so many applications today that it is a practical item of industry. So in discussing the future bearing of developments in the recent past, we are but looking at the shadow which coming events cast before them.

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C. J. Prendergast, Manager of Bailey Meter Company's St. Louis office, was fatally injured in a building collapse at Paoli, Indiana, on Friday, November 20, 1931.

Mr. Prendergast was in conference with four other men in a small two story office building when a section of the brick wall in a warehouse next to the office building suddenly collapsed and crashed through the roof of the smaller building. Mr. Prendergast was directly in the path of the falling material and was buried under considerable debris, although none of the other men were seriously injured. He was rushed to a hospital, where he died of internal injuries the following day.

After being graduated from Case School of Applied Science in 1925, Mr. Prendergast went directly into the employ of Bailey Meter Company at Cleveland, in whose employ he remained until his death. Before being transferred to St. Louis, he served as sales representative in the Boston and Springfield, Mass., territories.

W. C. Pinkerton has taken a position as Industrial Representative with Foster D. Snell, Inc. He was previously with the International Exposition Co.

"Let's Build One Ourselves"

By JACKSON BURGESS*

THE RELATIVELY high price of instruments as compared to other commodities bought by industrial firms and research laboratories is recognized and accepted in most cases as a result of the functioning of the economic law of supply and demand combined with an appreciation of the cost of development. Few are those who ever attempt to effect savings by building their own analytical balances, fuel calorimeters, recording potentiometers, or control devices instead of purchasing such equipment from logical suppliers. It seems to be well recognized that costly development effort has been expended, and that this cost has been reasonably distributed among all of the instruments sold; consequently, although prices are not low, they are acceptable.

The happy circumstance of price acceptance, although general, often does not apply to those instruments employing vacuum tube amplifiers or other electronic devices. The manufacturer who enters into this field must recognize that added sales resistance will be encountered, and that his prices will almost universally be compared to the present day prices of radio receivers. This exception to the general rule of price acceptance is apparently the result of two distinct causes.

Foremost as a cause for the non-acceptance of prices of "electronic" instruments is the layman's conception of the vacuum tube combined with his knowledge of its price in a badly over-produced radio market. The vacuum tube represents modern invention; it performs miracles; it can do anything. Consequently, when it is used in an instrument whose principle of operation is not clearly understood, it is invariably credited with being the sole necessary factor in making the instrument operate. The other units seem to be of secondary importance; they are drab and uninteresting. The research, development, and careful testing of all of the parts is, of course, invisible. Instruments employing vacuum tube amplifiers are always associated with radio receivers, and the layman is surprised at the disparity in prices.

Secondly, most industrial concerns and practically all research institutions employ electrical engineers or radio amateurs who have a partial knowledge of the design of "electronic" instruments, and who are confident of their ability to design and make the instrument being considered. Management sees an opportunity to save some money by authorizing the engineering department to build the instrument, and the work is started with enthusiasm. Within a week a bread-board model may be finished—a model which shows promise of being successful. A few adjustments here, and a slight change of the circuit there should turn the trick. Then comes the struggle. The little

(Continued on Page A21)

*President, Burgess-Parr Company.

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1931 Developments in

Industrial Process Instruments

By M. F. BEHAR*

ECONOMIC writers, now relating instances of manufacturers and retailers weathering the 1931 storm by studying the needs of their markets and bringing out better products, could find an inspiring example in the courageous policy of the manufacturers of industrial instruments, who did just that. Nearly all of these improvements were described from month to month in the "New Instruments" department of *Instruments*. This review, therefore, need not go into technical details—except for recent new instruments not previously illustrated and described. It will consist of two parts: (1) industrial measuring instruments—covering indicators, recorders, integrators and their accessories; (2) controlling instruments and systems—including not only controllers but recorder-controllers and power devices.

I—INDUSTRIAL MEASURING INSTRUMENTS

Temperature

General

A 1931 development applicable to remote indicating, recording and controlling temperature instruments is the new Tycos compensated tubing whereby temperature fluctuations affecting the connecting tube between the bulb and the panel-board instrument cannot affect the latter. This consists of a wire inside the capillary, both being scientifically dimensioned and of scientifically selected materials. From the details released by the company, this tubing appears to be an improvement over the wire-containing capillary brought out in 1920 by Negretti & Zambra in that it compensates for any form of temperature gradient along the tubing as well as for any differential between the average temperature along the tubing at the time of factory calibration and this average temperature at any subsequent time.

The Foxboro Company's Anti-Ambi thermometer is likewise designed to give true bulb temperatures, regardless of temperature of tubing and "head" of system, i. e., pressure-spring in instrument case. The principle of its operation has not yet been disclosed.

Indicating Thermometers

The mercury-in-glass thermometer, with suitable mechanical protections for industrial purposes, continues to hold sway as the most useful and widespread temperature instrument. With a plain tubular stem it would be hard to read. Last year, the Scientific Instrument Co. brought out *black*-backed mercury thermometer tubing whereby it is claimed that "in fact you can see the mercury from 15 to 20 feet away."

New lines of dial-indicating thermometers came out last year. The Foxboro Co. added one designed especially for wash wheels, featured by "the longest working scale of any thermometer of its size" and by a bulb readily installed on either a wood or metal laundry machine. The Moto Meter Gauge & Equipment Corporation announced a rigid-stem and a flexible connecting tube quadrant instrument.

Pyrometers

The General Electric Company announced a system of high temperature measurement and control comprising a radiation receiver and a photoelectric current amplifier ending up in an industrial form of indicator, recorder, or controller.

The Illinois Testing Laboratories, Inc., brought out a new form of contact pyrometer—an admirably simple portable instrument consisting of a handled millivoltmeter to which is attached a pair of pointed thermocouple wires which merely have to be pressed against the hot metal surface.

The Pyrometer Instrument Co. introduced to the U. S. the new Rapid Recorder brought out by Dr. Haase in Germany. It consists of a highly sensitive short-period moving coil system on a vertical axis. The staff of the moving system carries, instead of a metal pointer, an angular forked holder on which rests a thin glass capillary. The ink rises by capillary action and passes through it to the point over the chart. Free movement is achieved by a small hammer which strikes the paper under the pointer about 50 times per second. Friction is thus practically eliminated.

Before becoming a Division of the Foxboro Co. the Wilson-Maeulen Co., Inc., came out last summer with a new series of Tapalog recording pyrometers for single and multiple records, for either base-metal or rare-metal thermocouples, up to 3000°F. The improved Tapalog was entirely redesigned mechanically to adapt it to the use of an improved industrial type of electric synchronous motor clock of good power output, which can be connected to lighting circuit or regular plant source of a.c. power. The new Tapalog provides a recording cycle of greater frequency. The chart is 6 inches wide for each record, whether single or multiple.

Another new potentiometer pyrometer came out when the Brown Instrument Co. added this class of instrument to its millivoltmeter pyrometers. Fea-

*Engineering Editor, INSTRUMENTS.

tures: Slide wire 40 inches long, of spiral form, enclosed in a glass container; a rugged secondary pointer which "shadows" the galvanometer pointer and commands the adjustments of pen and slide-wire contact; humidity compensator for paper chart dimension variations.

The Leeds & Northrup Co., which for years was the only maker of industrial potentiometric instruments, allowed neither the depression nor the appearance of another line of potentiometers to subdue its spirit. It came out later in the summer with "Micromax," an improved potentiometer pyrometer of which three basic improvements are, briefly, increased sensitivity, self standardization, rapid recording.

Pressure

Liquid Manometers

The Amthor Testing Instrument Co. brought out a new single-tube mercury-column manometer with several improvements of which the most visible is the greater ease of reading.

The Meriam Co. brought out a new design U-tube manometer which can be dismounted and re-assembled with remarkable ease.

The Dwight Mfg. Co. brought out the Dwyer portable inclined-tube draft gage, of which the entire body is one solid block of transparent material in which the inclined "tube" and oil chambers are drilled and accurately reamed. No metal casing. No separate glass tube. Ingenious!

To its extensive line of inverted-bell pressure and draft indicators the Ellison Draft Gage Company added a new tandem system straight-line movement designed particularly as a visual aid to zoned air flow control under large forced draft stokers. Standard Ellison movements are arranged in pairs with two rows of pointers in the unit, one above the other in the same casing and with the bells one in back of the other in the same oil pan.

Tube-spring Gages

The new "American Duragauge" of the Consolidated Ashcroft Hancock Company, Inc., features a greatly improved movement of nitralloy steel. Another feature is the spring-tube bored out of special alloy steel, whereby linearity is assured. The gage hand or pointer now has an integral micrometer adjustment to make it easy to compensate for water lag.

The Foxboro Company developed a 6-inch dial gage with special chrome-molybdenum Bourdon tube and hardened steel movement designed to last long under extremely severe service conditions. Provisions against leaks are embodied. The cast iron flanged case is fume-tight.

Later in 1931, an all-steel gage was brought out by the Crosby Steam Gage & Valve Company, of which the new special alloy Bourdon tube is precisely machined, carefully rolled to shape, and heat-treated, resulting in a pressure-responsive element of remarkably linear characteristics.

A new alloy-steel helical tube-spring recording gage was developed by the Foxboro Co. All-welded steel construction—no solder, no brass.

Remote-reading Pressure Indicators

The most noteworthy long-distance system of the year is that brought out by the Bailey Meter Co. It has the Selsyn motor system of long-distance transmission which is not a 1931 development, but the remarkable feature is one which the Bailey people haven't stressed, namely, the fact that the primary pressure-measuring device is "primary" in the scientific sense, being a gravity-loaded element of the dead-weight gage class. By means of a hydraulic torque amplifier and of the Selsyn system it is possible to have greatly suppressed scales on the 42-inch diameter remote indicators.

Another remote-reading system for pressures, developed by the Westinghouse Electric & Manufacturing Co. particularly for pipe-line pumping stations, is of a contact-making type whereby pressure changes result in a code of impulses sent over the regular supervisory control wires, so that no extra live wires are needed. "The contact carried along the pointer has no mechanical connection to the rest of the device."

The third of the three electrical distant-reading pressure instruments announced in 1931 is the General Electric Company's aircraft gage which comprises a bellows primary element acting on a variable-resistance device at the transmitter. The bridge principle is employed to give pressure indications on the dial of the receiving instruments.

Pressure Gage Accessories

The Meriam Company's new Pulsation Shock Absorber makes it easier to read gages connected to lines in which the pressure fluctuates. It contains coiled fine tubing through which the pressure has to pass and is designed for line pressures up to 10,000 lb. Quite similar in purpose is the Utility Pulsation Dampener brought out by the Martin-Decker Corporation. The Pressure Snubber Company's device came out in 1930 but last year they developed it further and also added an ammonia type Snubber to their line. The new Gage Protector brought out by Champion & Barber does not dampen fluctuations much, but it makes it possible to use any suitably-ranged gage for the measurement of pressures of corrosive fluids.

Testers

Though developed for checking aircraft instruments, the complete line of testers brought out by the Aircraft Control Corporation (except the turn indicator tester) can be used for checking industrial pressure-measuring instruments. The vibration test stand is an interesting feature.

High-vacuum Measurement

The Continental Electric Co. brought out the "True-Vac Gage" in two models, a self-contained portable outfit and a remote-reading system. The makers do not state what principle of high-vacuum measurement is employed. All we can say is that the primary element somehow operates an electrical transmitter, and the vacuum is indicated on an ordinary flush-type milliammeter.

Time

While no fewer than nine manufacturers came out with automatic timing and programming controllers, only two new elapsed-time measuring instruments were developed in 1931—one an indicating (registering) instrument; the other a recorder.

An indicating (registering) elapsed-time meter was brought out by the General Electric Co. It contains a synchronous motor which operates while the circuit is closed and drives a five-digit cyclometer counter which reads in hours or minutes.

Designed for motor vehicles but applicable to most production machines, the Ohmer-Kienzle Vibracorder brought out by the Ohmer Fare Register Co. records running and idle time on a 5-inch round chart which has a one-day period of rotation but serves as a weekly chart by reason of the spiral recording. Every time the instrument cover is opened for access to the chart, a tell-tale perforation shows just when this was done.

Speed

Indicators

Two new stroboscopes were brought out, one of the interrupted light type and the other of the intermittent light source type.

The Tackiscope, a French instrument, was introduced to the American market by Robert Donner. It has a 200-watt incandescent lamp, a motor-driven revolving mirror, a friction type governor and a speed indicator.

The Vibroscope, brought out by the Electrocon Corporation, is a neon-tube stroboscope comprising a powerful three-lamp projector, a motor unit with breaker head at one end and governor at the other end, and either dry cells or a storage battery. It weighs 24 lb. complete.

Recorder

The American Askania Corporation introduced to the American market the Askania Werke's aircraft engine tachometer which has a combination centrifugal and pressure transmitter to which may be connected, by pneumatic tubing, any selected model of speed indicator or recorder. The recording tachometer is operated by impulses from a clock which can be located in another part of the aircraft.

Flow

The C. J. Tagliabue Mfg. Co. announced last fall the TAG line of instruments for the measurement and control of fluid flow. The primary element (a thin-plate orifice) and the meter body (a mercurial differential manometer) employ time-tried principles, but the latter embodies interesting novel features. Among these: (1) elimination of pressure-tight bearings; (2) one leg of manometer, though of perfectly circular *cross*-section at all points, has a suitably shaped *longitudinal* section, so that the float displacement in the other leg varies not as the square of the rate of flow but in direct proportion—which makes possible uniformly graduated charts and also facilitates solving flow control problems.

Foxboro's new recording, integrating and indicating flowmeter is designed for use where indications are to be read from a distance. The 8-inch indicating dial sits on top of the standard 12-inch round form recorder-controller, being rigidly attached thereto by a special casting through which passes the actuating link. Hence, no loose play.

For the visual measurement of smoke density by comparison, the Smokometer, brought out by the Sales Corporation, comprises a projector mounted on one side of a gas passage, uptake, flue or stack and an indicator mounted on the opposite side. The projector throws across the passage a beam of light which falls on the central portion of the indicator. Around this central screen there are illuminated segments graduated in the Ringelmann scale of smoke densities. It is possible to reflect the image to various points, as for instance to a mirror in the fire room and one in the engine room or chief engineer's office.

What a recording radiation pyrometer is to an optical pyrometer, so is the new Leeds & Northrup Smoke Recorder to the device just mentioned. This recorder has a primary element similar in general principle (dimming a beam of radiation that passes across the flue) but the receiver is a temperature-compensated thermopile which forms the primary measuring element—the final recording instrument being a regular-form L & N potentiometer.

Properties

The new Blow-off Hydrometer brought out by the Permutit Company is designed especially for measurement of saline concentration to aid in producing steam of good quality.

The Electro-Viscometer, developed by the DeVilbiss Co. measures viscosity by rotating an impeller immersed in the liquid and gives almost instantaneous readings on a scale so designed that the units vary for a given liquid density approximately with the logarithm of the absolute viscosity. Calibration charts permit converting DeVilbiss units into Saybolt seconds or Engler degrees.

The Visco-Meter, brought out by the Visco-Meter Corporation, is connected with the oil pressure line where working pressures exceed 8 lb/in.^{2}. An automatic unloading valve reduces a small portion of oil to a constant 5 lb. pressure in the chamber. The oil then passes through the calibrated orifice into a divided chamber. One branch is connected with a calibrated capillary resistance tube; the opposite branch is connected with an indicating gage.

Similarly, the "Lubri-Guide," a new automatic viscometer brought out by the Viscosity Engineering Corporation, gives indications on a dial. It consists essentially of an ordinary pressure gage measuring the head set up by oil flowing through a friction tube at a rate held constant by a diaphragm and ball check arranged somewhat as in an ordinary reducing valve.

The specific gravity of a gas is continuously measured, indicated on a 9-inch wide scale and recorded on an 8-inch diameter round chart, by a new model Ranarex developed by the Permutit Company.

Salinity is continuously measured and the result indicated on a remote dial graduated in Grains of

Chlorine per Gallon, by means of the Sperry Gyroscope Company's new Salinity Indicator System. The primary element is a conductivity cell.

Under the measurement of weight we could mention many minor improvements in industrial scales but the only radically new industrial development appears to be an optical quick-reading device, the Weightograph, brought out by the Howe Scale Co., which can be attached to any built-in type of beam scale from 1000-lb. up. It is *not* a graphic device: "Weight*oscope*" would have been an exactly descriptive name.

Composition

In addition to new CO_2 meters brought out by the Permutit Company and by Charles Engelhard, Inc., a new fuel-and-air ratio meter was brought out by the Bailey Meter Co. which dispenses with the usual cams and mechanisms of "computing" types of ratio instruments. When the meter is installed on a boiler, an adjustment is made whereby coincidence of the two records on the chart expresses the optimum ratio for this boiler. Thereafter the furnace operator strives to keep the two pens together.

II—AUTOMATIC CONTROL INSTRUMENTS

General

Two developments in automatic control instruments generally applicable to temperature, pressure, flow, etc., were placed on the market in 1931.

The Minneapolis-Honeywell Regulator Company brought out a control system employing electric power but without the usual limitations of plain motorization—being designed to give gradual throttling or proportioning modes of control as do fluid-relay control systems, but without the principal shortcomings of compressed-air operation. For detailed description of this achievement consult the New Instruments section of this issue.

The Bristol Company's line of air-operated recorder-controllers features the new "Free Vane" which, as the final element of the primary system, commands the pneumatic power device that operates the controlled valve, damper, or other supply-governing device. This vane moves freely between two opposed air jets, thus imposing no drag on the measuring system. Consequently, in a temperature recorder-controller for example, the pen-arm can never be pulled away from its proper position on the chart by any variation or disturbing factor of any sort in the air-power elements of the control system. Moreover, variations in the force factors at the power end—such as fluctuations in steam pressure in the case of a diaphragm-valve on a steam line—cannot cause displacement of the free vane.

Temperature

The Automatic Temperature Control Company's two-motor "balancing control" mechanism has been modified and the improved device incorporates an additional three-position switch for the initial motor and substitutes a cam action for the time lag gearing on the balancing motor, so that the balancing motor comes into play immediately. In addition to the "high," "low" and "normal" contacts used to operate the earlier control mechanism, there are required two additional contacts, "high prime" and "low prime," for this new type. Availing themselves of the opportunity presented by this new A.T.C. development, manufacturers of pyrometric controllers have begun to provide these additional contacts. The combination of such pyrometric controllers with the A.T.C. Co.'s new operative mechanism now gives the metallurgical and ceramic industries an improved method of temperature control.

For the automatic temperature control of industrial ovens the Paul Maehler Company developed the Maehler Electrical Control Unit, which embodies in one compact and automatic unit the functions of their various individual control devices heretofore used in connection with oven operation.

The Taylor Instrument Companies brought out a redesigned Indicating Pyrometer Control which weighs 3 pounds less and is vibrationless.

The Sarco Company added to its line of temperature regulators a new one which makes the steam (or other heating medium) control itself by its own pressure. Unlike the steam-operated controllers which gives throttling control, the new Sarco instrument gives on and off action.

The Hevi Duty Electric Company brought out an automatic excess temperature cutout which can be applied to any type of furnace to guard work or furnace from damage due to overheating. The instrument responds to a thermocouple located in the furnace chamber which actuates a thermal cutout to control a relay which is a part of the furnace control system.

Humidity

The Saturation Controller brought out by the Foxboro Company is designed to solve the problem of correctly saturating natural gas to prevent the drying out and subsequent leakage in any line formerly used for the distribution of manufactured or wet gas. The primary system is a wet- and dry-bulb psychrometer. Control of the saturation point is obtained by the wet-bulb thermal system which operates a controlled valve in the steam line leading to the aspirator.

Pressure

There are more than 100 makes of pressure control systems, instruments, devices, etc., and so many developments took place that a special Annual Review would seem called for . . . if it were not for the fact that not a single basically new instrument was brought out. Our apologies to designing engineers whose improvements would have been described had there been more space.

Timing, Sequencing, Etc.

Ten new developments—eight in plain time switches and sequencing controllers, and two in the way of condition-time gradual-change control.

The Walser Automatic Timer Company added a new model, allowing fractional minute settings of from 5 seconds to 4 minutes. Up to 6 amp., 110 volt, a.c. or d.c.

A new time switch brought out by the Sangamo Electric Company has its mainspring kept wound to constant tension by a noiseless motor. Period of operation can be varied from one open and one close in 24 hours to one operation every 15 minutes.

R. W. Cramer & Co., Inc., brought out a new Sauter Electric Time Switch with a small induction motor which is on the line only twenty-five seconds every twenty-four hours to fully wind the clock spring. The standard dial is designed to control either one or two complete cycles in twenty-four hours. If more operations per day are required, additional arms can be supplied.

A new time switch, brought out by the General Electric Co., is available in single or double-pole, both single or double-throw, and with either a plain or an astronomic dial.

The Monitor Controller Company brought out the Work Cycle timer, in which the switches are on disks co-axially mounted on a sleeve. When the desired sequence is completed, all switch disks drop back to their respective starting positions.

Two types of pneumatic cycle controllers were brought out by the Bristol Company: a single-cam type whereby a number of pilot valves are actuated in turn by the cam, and a type in which several cams are mounted on a common shaft for use where the events in the cycle overlap by varying degrees.

The new time cycle regulator of the Taylor Instrument Companies consists of an electrically driven cam which, as it revolves, progressively opens or closes small pilot valves. These valves in turn regulate the supply of compressed air to diaphragm valves, electro-pneumatic switches, etc.

With the new timer for individual vulcanizers brought out by the C. J. Tagliabue Mfg. Co., it is possible to change the cure length in a few seconds' time because it is only necessary to reset the reversing arm at the new time on the cam which is graduated in minutes. The period during which the tube is venting has also been made fully adjustable by having a separate cam sector govern this operation.

Announced last fall, the new Foxboro Company's non-recording time controller, is designed for providing a temperature-time or a pressure-time cycle according to a specified curve. The cam is a printed aluminum disk the size of a standard Foxboro 10-inch chart, printed from plates similar to those used in the printing of Humitex charts. New cams to meet changed conditions can easily be cut by the user.

Continuing its research program on nitriding, the Leeds & Northrup Co. has investigated the four principal processing conditions that have to be controlled: (a) temperature, (b) time, (c) materials—other than the work itself—in the reaction zone, (d) rate and manner of flow of the active chemical. Messrs. Harsh and Muller of Leeds & Northrup Co. report securing suitable sequencing of operations and temperature-time programming that can give the desired surface hardness *and* gradation of case *and* depth of penetration, which is an achievement indeed. Moreover, if a certain case depth is required, a suitable program can be laid down to produce it in a shorter time and with considerable savings in fuel and ammonia.

Liquid Level

Cutler-Hammer, Inc., brought out a new float-operated motor starter for small a.c. and d.c. motors on out-of-the-way applications where reliability is essential. It is small in size, provides across-the-line starting and thermal overload protection.

The Bailey Meter Company's new system for maintaining at the optimum level (*not* at *one* level) the water in steam-boiler drums is too long for description here. Suffice it to mention that in modern boilers with relatively small drums a sudden increase in load causes such an increase in the volume of steam bubbles below the surface that the level *rises*. An ordinary liquid-level controller would shut off the feed instead of increasing it—as the Bailey system then does by reason of its being responsive not only to water level, but to rate of steam flow from the boiler.

Properties

Automatic control of weight or volume of material in connection with filling and packaging received a fresh impetus, with several ingenious controllers making their first appearance. The Cut Off Weighing Device brought out by Toledo Precision Devices, Inc., has two dials, with a cut-off setting hand on one. The substance to be weighed off flows into a container on a scale until the setting is reached, when the cut-off hand intercepts a light beam, actuating a photo-cell relay.

The calorific value of fuel gas is controlled automatically and continuously by a system brought out by the Brown Instrument Company. The primary element is a "Flame Analyzer" which translates the value of the heating effect into an electrical magnitude, so that a standard panel board recorder-controller initiates a valve command system whereby the gas is enriched or diluted.

Composition

The Air-Butane Ratio Controller brought out by the Foxboro Company will automatically mix butane and air in the proper ratio. This instrument, a ratio-flow recorder-controller, is based on the orifice principle, and operates a controlled valve with air or gas.

The correct proportions of various aggregates for cement are automatically weighed out by the new Aggregate Auto Gage of Toledo Precision Devices, Inc., which moreover compensates automatically for the surface moisture in each.

Length, Etc.

An automatic screwdown controller for providing proper adjustment of the rolls in rolling mills was brought out by the Westinghouse Electric & Manufacturing Company. With this controller a predetermined amount of reduction of the distance between the rolls is arranged for by plugging in leads at certain points, and, when the mill is in operation, this screw-down is provided automatically at the correct intervals. Using this apparatus, one man can operate the entire mill.

Electrical Measurement Developments in 1931

By E. S. LINCOLN*

DEVELOPMENT of electrical measuring instruments during the past year has continued its tendency of refinement and accuracy, with no radical departure from principles already established. With few exceptions, the development of new instruments has been confined principally to those measuring non-electrical quantities, but using electricity as a means.

Space does not permit a detailed description of each instrument developed during the year. But most of the new developments were described monthly in the New Instruments Section of this magazine, so a reference has been made to the page of INSTRUMENTS, Vol. 4, 1931, where details may be found.

All manufacturers of electrical measuring instruments have added new products to their existing lines and have extended ranges of regular models.

Improvements have been made in existing equipment, such as current and potential transformers, where ranges have been increased and accuracy bettered. Some changes have been made in ammeters and voltmeters, especially in the smaller sizes to increase their accuracy and decrease their cost.

ELECTRICAL QUANTITIES

Instruments for measuring electrical quantities are still undergoing a reduction in size, and one of the latest developments along this line has been in the small size, flush type rectangular instrument illustrated in Fig. 1. These instruments measure 4" x 4⅝", and are well adapted for control boards where space is limited. Scales are easily read, and all connections are accessible from the front of the board.

A light weight volt-ammeter for airplane battery circuits is illustrated on page 113. This instrument is of the flush type and is extremely light in weight and small in diameter.

A combined direct current volt-ohmmeter reading up to 600 volts and having a resistance of 1,000 ohms per volt was developed during the year. The same instrument may be used also as a direct reading ohmmeter with ranges from 0-10,000 and from 0-100,000 ohms. This instrument is well adapted for radio work and is described on page 117.

A new line of new a.c. instruments of the portable type using a copper oxide rectifier and a permanent magnet moving coil galvanometer has been developed and is described on page 620. These instruments require a very low energy consumption. They are adapted for general use, especially for low readings, and have ranges from ½ to 20 milliamperes, and for voltmeters having scales reading 3 or 4 volts for the full scale.

*Consulting Electrical Engineer, New York, N. Y.

For measuring insulation resistance up to 200 megohms, using 1,000 volts, a small "Super-Meg" has been developed which is found very convenient for use in the field on account of its light weight and small size. (See page 199.)

For measuring accurately alternating current of any frequency with a sensitive direct current instrument, a new vacuum thermocouple has been developed. This thermocouple is sealed in a vacuum bulb. (See page 558.)

Another set of vacuum thermocouples for measuring weak alternating currents is described on page 472.

A precision potentiometer has been developed. This potentiometer is extremely sensitive and has a range of from one microvolt to 2.1 volts. (See page 459.)

A thermocouple potentiometer has also been developed which does not require the use of the standard cell and has several features that will be of considerable interest to the laboratory engineer. (See page 559.)

A very compact resistance measuring bridge weighing only 3 lbs. will be found useful to test-room employees and for use in the laboratory. Such a bridge, which has an accuracy of about 1% and is made in two sizes—10,000 and 50,000 ohms, respectively. (See page 633.)

Graphic instruments have undergone several refinements and are now available in flush types. (See page 565.)

Portable types of recording instruments have also been improved and are described on page 701.

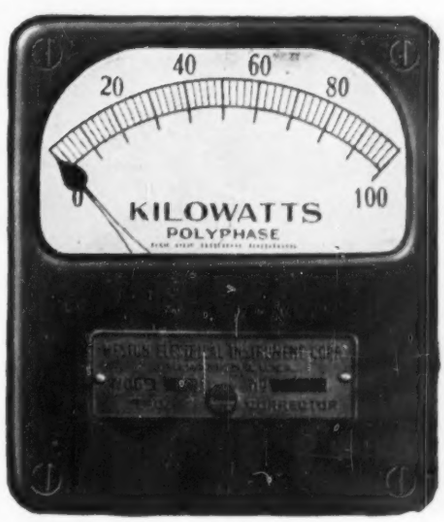

Fig. 1. Compact New Switchboard Wattmeter.

A photoelectric recorder has been developed for measuring volts and amperes which is more sensitive and accurate than the ordinary graphic instruments. This is obtained by using a different principle incorporating the use of photoelectric and pliotron tubes. The inking pen, which is controlled by the tube circuit, receives its energy from an auxiliary source. (See page 403.)

Recording demand watthour meters have undergone several improvements, so also one used for measuring kilowatt-hours and integrated demands in kilowatt-hours over successive predetermined intervals. (See page 468.)

Under this heading also comes a KVA-demand meter which contains 2 watthour meters and a chart for making various measurements. Such an instrument will be found extremely useful in metering industrial loads where power factor and demand are taken into consideration. (See page 259.)

Two instruments that have been developed especially for radio service are the mutual conductance meter for measuring the mutual conductance of radio tubes, which is a product of the Weston Electrical Instrument Corporation, and the new output meter, also developed by them. This latter instrument is especially useful in checking radio sets, sound projection equipment, and public address systems.

Another mutual conductance meter operating on the dynamometer principle has been developed by the Sensitive Research Instrument Corporation. This same company has also developed an ultra-sensitive microammeter. This instrument has a range of 0.25 micro-amperes and has a resistance of 3500 ohms.

Fig. 2. New High-Sensitivity Meter.

Fig. 3. Portable Phase Sequence Indicator.

The conventional domestic type watthour meter, as made by American manufacturers, has undergone several improvements. These improvements were made to covers, connections, methods of mounting, and other miscellaneous features. Today this particular meter has a great accuracy over a very wide range of loads, and is certainly a credit to its manufacturers.

ELECTRICAL QUANTITY RELATIONS

For use in totalizing loads in several alternating current circuits, a new thermal converter has been developed which, by means of thermocouples, produces direct current voltages which may be connected in series for totalizing purposes. This device should be useful where total readings are required for various individual circuits. (See page 471.)

During the past year, considerable attention has been devoted to improvements in oscillographs. On page 362, an automatic oscillograph is described. It is especially developed for continuous check on relay operations and high-speed switching. The record is produced on a special photographic film and the device operates automatically without attention until 200 feet of this film have been exposed. Such an instrument will be found very useful in studying circuit conditions over considerable periods of time. A similar automatic oscillograph is described on page 459.

A string oscillograph and recording camera, described on page 409, is well adapted for use in laboratories, schools and colleges. This instrument is adapted for any kind of oscillographic work where the maximum frequency is below 3,000 cycles per second. The instrument is particularly adapted for studying sound impulses.

As a result of television development, a new cathode-ray oscilloscope has been developed. This is a portable, high-speed instrument for visualizing periodic electrical phenomena and will catch events last-

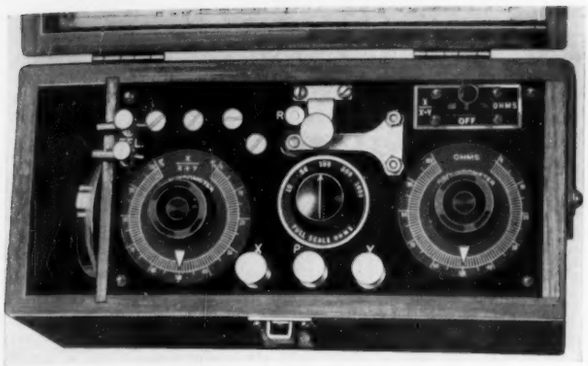

Fig. 4. Ground Resistance Measurer for Field Use.

ing but a millionth of a second. This device is described on page 573.

One of the most sensitive electrostatic instruments ever built is the Compton electrometer described on page 110. It is of the quadrant type as originally invented by Lord Kelvin, and sensitivities as high as 50,000 mms. per volt have been obtained.

In checking connections of polyphase systems for motors, relays, etc., where the phase relation of a circuit must be known, a portable phase indicator is described on page 244. Such an instrument will be found very convenient by the service departments of public utilities and industrial plants in general.

Another phase sequence indicator is a portable instrument put out by Herman H. Sticht & Co. of New York. In this particular instrument the direction of rotation is given in the movable disc in the center of the instrument.

It is very essential that when grounding electrical apparatus, the ground itself has as low a resistance as possible. In order to determine what the resistance of a ground may be, a special instrument has been developed. This groundometer is manufactured by the Borden Electric Company, of Newark, N. J., and offers a ready means of checking ground resistance in the field.

MEASUREMENT BY ELECTRICITY

A large number of instruments have been developed for measuring various quantities where electricity serves as an agency of measurement. These instruments are quite varied and are appearing in greater number from year to year. Such instruments are extremely useful in various industries and are receiving careful consideration by the manufacturers. Many of these instruments have been developed by manufacturers for use in their own plants, but as time goes on they are being placed on the market as standard products, in many cases by the makers of electrical instruments.

Gas

The ever increasing use of electricity as a means for numerous measurements is well illustrated in the portable gas analyser, described and illustrated on page 625. Termed a "Gasalyser" by its makers, the analyser operates on the principle of thermal conductivity using a millivoltmeter as its electrical indicator. Its use is not confined to one gas but to many, such as acetone, carbon dioxide, butane, hydrogen, carbon monoxide, helium and many others.

Instead of a millivoltmeter, a milliammeter connected in a Wheatstone bridge-circuit may be used for analyzing exhaust gases from internal combustion engines. On page 47 is described an exhaust gas analyzing device using this principle, which is well adapted for determining the proper fuel mixtures of engine carburetors.

Mechanical Measurements

The uses of instruments employing magnetism direct are as varied as those employing electricity direct, and undoubtedly other such instruments will continue to the perfected. The development of another magnetic type instrument which is used in measuring stresses and strains in structural steel, rails, etc., is described on page 200, and is known as a magnetic strain gage.

An electric gage for making measurements of one one-hundred thousandth of an inch and magnifying infinitesimal dimensions 10,000 times, so that they may be easily visualized, is described on page 45.

Another instrument for making comparisons by checking within very close limits is the electrolimit gage, described on page 507. This instrument makes magnifications from 500 to 10,000 times, and measurements of 1/10,000th of an inch for both inside and outside diameters are possible.

Pressure and Vacuum

For the remote measurement of pressures, a multicontact making pressure gage is described on page 513. This particular gage is used with supervisory control systems to indicate automatically pressure readings at a remote point.

For indicating the exact degree of vacuum in a vacuum system at a distant point, the Tru-vac gage has been developed, described on page 518. This gage indicates conditions continuously and shows instantaneous changes in the vacuum.

Sound and Vibration

Electricity as a means of measurement is also found in the Acoustimeter, which is described on page 197. This meter is very useful in locating the sources of vibrations in machinery and for measuring noises in rooms, etc.

Electricity, through the medium of neon tubes, a motor and proper circuits, makes possible a new vibroscope, used for observing high-speed motion. This portable vibroscope, while not a measuring instrument, is of great value as an accessory in studying operations which are further analyzed with various instruments. On page 125 is a detailed illustrated description.

CONTROL EQUIPMENT

Many devices for automatic control of one form or another are developed each year, and those using electricity are mentioned here as they constitute important accessory apparatus for various measurements. The automatic excess temperature cutout, described on page 136, comes under this classification and is used to prevent the overheating of a furnace.

(Continued on Page 14)

The Laboratory Apparatus Industry in 1931

By ARTHUR SCHRODER*

THE year 1931 tested the resources of the laboratory apparatus industry to the limit. In June of last year the United States felt the real brunt of the depression. As all industries curtailed production their demands for testing equipment were proportionately reduced. The schools, usually heavy buyers during May, June and July, also felt the effects of the depression and purchased in accordance with reduced budgets. By September most jobbers found themselves with excess stock, dwindling markets and a nation-wide tightening of credit. These conditions compelled many of the dealers to reduce prices in order to turn over their stocks and convert them into ready money. By December most of the excess stock had been worked off, and the market, while still spotty, had regained its stability.

In spite of this unsteady economic background the apparatus industry found time to develop a number of new instruments, most of which have been described in previous issues of this magazine.

For metallurgical use, three new specimen polishers have been announced, and three new modifications of the Brinell hardness tester have entered the field. A series of proving rings for calibrating tension and compression test machines with a range of 6,000 to 200,000 lbs. have been placed on the market by the Morehouse Machine Company. The field of temperature measurement has been invaded by a new optical pyrometer of the disappearing filament type, and several modifications of contact pyrometers.

The Denver Fire Clay Company has developed a new portable furnace for determining the pyrometer cone-equivalent tests on refractory materials, and a high temperature kiln for research purposes. The Emerson Company have announced their new stainless steel calorimeter bomb, and Burgess-Parr have improved their adiabatic calorimeter jacket. This company has also perfected the Dennis temperature-gradient electric melting-point apparatus, an improved turbidimeter, a new high pressure catalytic hydrogenation apparatus, and a new type of glass vacuum electric contactor. The Precision Scientific Company has brought out a universal penetrometer for determining the consistency of greases, petrolatum and asphaltic road materials, and also a new Tenderness Tester for determining the tenderness and resistance to crushing of canned foods as now required by the McNary-Mapes amendment to the Federal Food and Drugs Act. Tagliabue, Kuttner and Collins have each developed improved viscometers. Leeds and Northrup have brought out their new bridge for the conductance of electrolytes, while the Burrell Technical Supply Company has marketed the Larabee potentiometric titration unit for the determination of manganese, etc., in steel analyses. The Hellige colorimeter has been developed so as to be a direct reading, combined colorimeter and hydrogen ion apparatus of the double wedge type. One of the outstanding features of the year was the development of the Hickman line of high vacuum distillation apparatus and gauges, marketed by the Fisher Scientific Company. Another feature was the entrance of W. A. Taylor and Company into the field of hydrogen ion and chlorine control with an exceptionally complete line of apparatus employing liquid standards.

In addition to the above instruments numerous labor saving devices and apparatus set-ups for specific analytical tests have been developed.

Considering the economic handicap under which all manufacturers were working during the past year, the field of laboratory instruments has been appreciably enriched, and even now a sufficient number of developments are under way to give promise of interesting contributions during 1932.

*Technical Service Department, Precision Scientific Company.

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Electrical Measurement Developments in 1931

(Continued from Page 13)

A thermocouple located in the furnace chamber actuates a thermal cutout and in turn a relay for the final control of the fuel supply.

GRAPHIC REPRESENTATION

Extremely rapid records may be made photographically by means of the oscillograph, but for every-day use in the shop a rapid recorder will record on a chart temperatures or operations of machinery or parts of a process. This portable recorder is described on page 627.

ACCESSORY EQUIPMENT

Accessory apparatus, which is quite essential where using some measuring instruments, has received considerable attention. For protecting the circuits of delicate electrical measuring instruments, low capacity fuses have been developed having a capacity of ¼ of an ampere. These are described on page 115.

Current transformers having a split magnetic circuit are very useful in taking current readings on power circuits where cables cannot be disconnected. Transformers of this type built for use in connection with ammeters are described on pages 255 and 619.

Flow Measurement and Control*

M. F. Béhar†

1. Classification of Instruments Related to Flow

From the economic viewpoint, the importance of flow measurement and control becomes evident when we consider that industry itself, as a general phenomenon, is largely a flow of all manner of things from the sources of raw materials to the packaging machines, shipping platforms and points of consumption. Not only is the rate of this flow the pulse of the nation's industrial health, but every industry and every individual plant can be diagnosed with flow meter readings for cardiograms. Dollars and cents flow in all pipes and on all conveyors, in such forms as oils, gases, coal, steam, water and other raw and processed material. The exact count of these disguised dollars is as necessary as the proper conduct of the company treasurer's department and, for similar reasons, so is their careful "control" in the sense of allocation, disposition and terms of sale.

But these purely and directly economic considerations, important as they are, constitute only one-third of the picture—the financial background. In the foreground looms the engineering consideration that the success of industrial processes and operations depends to a large extent on the measurement of material. In some cases it is the material which is processed; in others the material serves as the medium which creates a given processing condition; but in all cases good results cannot be obtained without accurate measurements of the material, and optimum results call for exact automatic control of the material supplied or consumed.

The practical methods of measurement lead to a broad classification of instruments. Where material is measured in isolated quantities, such industrial instruments as platform scales and tank gages can be used. These, however, while related to flow of material in a general way, are not meters and are not dealt with in this Part of the Manual. Where continuous measurement is practiced, as in the case of continuous processes (or of batch process applications in which a condition is created by a continuous supply of medium), instruments are employed to measure the flow of material.

Not all these measuring instruments, however, are flow meters. The distinctions were pointed out in Chapters I and II. Some instruments perform automatically in continuous repetition the sort of function of a platform scale: they measure isolated *quantities* of material, regardless of rate and register the totals by means of counters. A wet-drum gas meter and a coal-conveyor totalizing weigher both fall into this general group. The flow meters proper are those which measure primarily the *rate* of flow and which may or may not integrate with respect to time to furnish additional counter readings of total volume or quantity. An orifice gas meter and a rotating-vane coal meter both fall into this general group.

In practice the engineer does not deal with material but with actual materials in all states. The variety of these materials and of their states compels a different classification of the industrial instruments pertaining to them—a classification based on readers' convenience. Thus, for example, instruments for the measurement of quantities of liquid materials at rest, as in storage tanks, are so remotely related to industrial flow control that they would not even be looked for under Flow by the readers. Therefore they are assigned to the chapter on Liquid Level. Industrial scales, too, have a chapter to themselves in Part VIII, but continuous measuring instruments—true "meters"—operated by the weight of the material passing through them are dealt with in this Part. Volumetric instruments designed for chemical laboratory work are outside the scope of this Manual; some of those designed for industrial measurements unrelated to flow are dealt with in other Parts; but it would be absurd to exclude those volumetric instruments such as positive displacement meters which, while they do not measure primarily rate of flow, will be looked for in no other Part than this.

*Part VI (Chapters XXI to XXVI) of the Manual of Instrumentation by M. F. Béhar. This instalment is Chapter XXI, General Introduction and Classification.

The Manual of Instrumentation has been appearing in monthly instalments in *Instruments* since January, 1930, under the title of "The Engineer's Handbook of Industrial Instruments." The change of title has now been made necessary by Mr. Béhar's decision to divide his general treatise into seven separately-bound Handbooks. The first of these, now being printed, is The Handbook of Industrial Temperature and Humidity Measurement and Control (Instruments Publishing Co., $4.00 postpaid).—Ed.

†Engineering Editor.

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STEAM METERS—Electrically operated—free from effects of voltage variation—available for all pressures—remote reading instruments.

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MEN AVAILABLE

INSTRUMENT MAKER: 3½ years experimental laboratory of lamp company; 2 years experimental laboratory of electrical company. J-2.

PYROMETER MAN: Graduate Pennsylvania State College. Had charge of pyrometer calibration laboratory in plant with 1100 pyrometers. J-3.

METALLURGIST: 1½ years University of Pennsylvania; 7 years night school Carnegie Institute of Technology. 2 years steel plant analyst; 7½ years plant metallurgist in foundry. Can read German, Polish, Bohemian and Russian. J-4.

ELECTRICAL ENGINEER: Graduate Charlottenburg Technische Hochschule; 8 years research engineer with chemical company; 4 years steel plant electrical engineer; can read German, French, Spanish and Italian. J-6.

INSTRUMENT SALESMAN: Mechanican Engineering Graduate; experienced sales and service most type of power plant instruments. District Sales Manager 5 years. Experience on gages, flow meter, CO_2 recorders, pyrometers and other testing equipment. J-8.

PYROMETER MAN: 8 years experience; expert electrician and gage (hydraulic, pressure, vacuum, etc.) service man; 3 years instrument laboratory; education equivalent two years of engineering college. J-9.

INSTRUMENT ENGINEER: Graduate Engineering College. Charge of instrument department in large industrial plant for 2½ years. J-10.

INSTRUMENT MAKER: Dip. Ing. Charlottenburg, 2 years German Instrument company building electrical and temperature instruments. 1 year patent research bureau in New York. J-11.

RADIO OPERATOR: Graduate Dodge Institute, 1917. Commercial license either broadcast or telegraph. J-12.

INSTRUMENT SALESMAN: Graduate M.E., 4 years control instruments, 2 years power plant specialties, 4 years manufacturing experience, in shop. Now N. Y. District Mgr. large rolling mill. J-13.

PHYSICIST: Ph.D. 1927. Experienced in electric and magnetic measurements, testing and research. J-14.

PRECISION INSTRUMENT MAKER: 28 years experience on scientific and geophysical instruments. J-15.

RADIO ENGINEER: Graduate University of Illinois; 2½ years experience in radio set circuit and tube measurements as well as development, design and patent investigation work. J-16.

ELECTRICAL METER and INSTRUMENT MAN: Technical graduate, 8 years in instrument laboratory of electrical manufacturing company. J-17.

INSTRUMENT ENGINEER: 2 years university, 5 years public utility, 2 years sales and service large recording and controlling instrument manufacturer. J-18.

INSTRUMENT MAKER: Engineering and Drafting instruments, 20 years shop experience. Master Degree Guild of Nuremburg. J-19.

ELECTRICAL ENGINEER: Graduate Purdue University. Experience with Telephone and Telegraph circuits, industrial control methods and equipment, and electrical instrument testing and maintenance. J-20.

Precedent and usage, too, impose the necessity of segregating most instruments for the measurement of materials in the plastic and solid states, in pulverized, granular and other forms, and largely restricting this Part to (1) the industrial measurement *(metering)* of fluids and (2) the automatic control of fluid flow on applications where flow itself is the controlled condition—which excludes, for example, the regulation of steam flow for the purpose of controlling the temperature of a steam-heated application. Not only do the measurement chapters of this Part deal mostly with industrial fluid meters, but in these chapters the classification follows closely that established by the A.S.M.E. This adherence to precedent is not a departure from the general scheme of the Manual. The subject matter of some other Parts had never before received an engineering treatment; what little work had been done was of so little usefulness to industrial engineers that it had to be ignored and a fresh start made. It is different with the subject matter of the measurement chapters of Part VI: A great deal of work has been done and most of it was done by engineers for engineers, so that in this case the nomenclature, classifications, definitions and other details must be respected.

But even if they were not in existence—if the author, desiring to be consistent, followed only his own terminology and principles of classification of *industrial* instruments (as laid down in Part I), Chapters XXI to XXV would probably not have differed greatly.

The concluding chapter, on automatic control of flow, is original, but an effort has been made to have even its classification of control instruments follow the A.S.M.E. classification of the meters insofar as possible.

2. Classification of Fluid Meters

Since 1916 the American Society of Mechanical Engineers has had a Special Research Committee on Fluid Meters at work, and its publications are considered the basis of this art, representing, as the Committee does, the points of view and the knowledge of designers, manufacturers and users of fluid meters. In order to put the classification of meters on a substantial basis, one cannot do better than to follow (and quote from) that Committee's report.

Functional Classifications. (A) "Groups"—Fluid meters are divided first into two functional groups: one group comprises the instruments which measure primarily quantity (Chapters XXII and XXIII); the other group comprises those which measure primarily rate of flow (Chapters XXIV and XXV). For further discussion of this grouping of all industrial metering instruments see Part I, Chap. II, Sec. 3.

(B) "Divisions"—All industrial indicating, recording and integrating instruments for the measurement of variables comprise "a part, or an assembly of parts, known as the primary element which responds to changes . . . or produces such a response."* Fluid meters are no exception. All consist of two or more elements—the primary element being that in contact with the fluid and directly acted upon by it. The second is the element which translates the action of the fluid on the primary element into volumes, weights, or rates of flow and indicates, registers or records the result. This secondary element is usually the "instrument" with its familiar dial or chart. For example, a weigher will have weighing tanks as its primary element and a counter for recording the number of fillings and emptyings as its secondary element. In an orifice meter, the orifice, with the adjacent part of the pipe and the pressure connections, constitutes the primary element, while the secondary element consists of a differential pressure gage together with some sort of mechanism for translating a pressure difference into a rate of flow and indicating the result, in some cases also recording it graphically and integrating with respect to time in order to register the volume that has been passed. The same sort of combination will be observed in other types of meters.

The secondary devices may obviously be varied almost indefinitely, but the primary elements depend for their operation on a few simple physical principles. It follows that fluid meters may best be classified with regard solely to the nature of the primary element or to the physical principle involved. Table VI—1 gives the A.S.M.E. classification in which the smallest division is the "type" according to form of primary element.

Positive Meters—The term "positive" is used to designate meters through which the fluid passes in successive isolated quantities, either weights or volumes. These quantities are separated from the stream by alternately filling and emptying containers of known capacities and no fluid can pass through such a meter without actuating the primary device. The secondary element of a positive meter consists of a counter with suitable graduated dials for indicating the total quantity passed through the meter up to the time of reading.

*See Chap. I, Sec. 5, on "Principal Parts of Industrial Instruments."

Weighing Meters—The term "weighers" is applied to meters in which the equilibrium of a container is upset by a rise of the center of the gravity as the container fills, or to those which employ a container suspended from a counter-balanced scale beam.

Volumetric Meters measure volumes instead of weights and for the sake of brevity are called "volumeters." The piston and disk meters are obviously volumeters.

Inferential Meters—The term "inferential" is used as the antonym of "positive." It is applied to all meters through which the fluid passes in a continous stream, and they may not actuate the primary device. In the inferential meter the quantity of flow is not determined by counting, but is inferred from the action of the stream on the primary element, by means of known physical laws or empirically determined relations.

The functioning of the primary element of an inferential meter depends on some property of the fluid other than volume or weight. This property may be inertia, viscosity, specific heat, etc. The secondary element is designed and constructed on the assumption that the property in question has a particular value. The secondary element, or "instrument" proper, embodies a means of automatically drawing the correct "inference." Such means, in its simplest form for the head meters (ch. XXIV), is a glass U-gage or differential manometer. With the exception of current meters (ch.XXIII) inferential fluid meters give, in the first instance, time ratio of flow, but the instruments for industrial service usually embody devices for integrating rate of flow with respect to time in order to meter the quantity of fluid passing through the primary element.

Current Meters are those in which the primary element is some device kept in continuous rotation by the linear motion of the stream. The secondary element is essentially a revolution counter and the instrument measures the total distance of travel of the fluid past the primary device.

Head Meters are those in which the stream fluid creates a difference in pressure or a differential head at the primary device, this head depending upon the speed and density of the fluid.

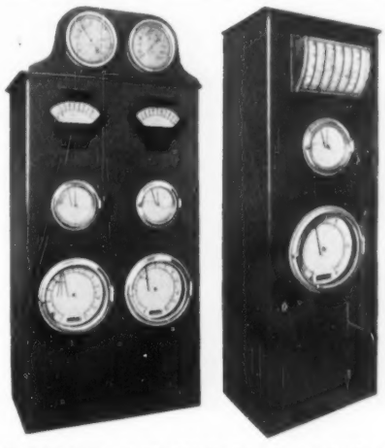
The venturi tube, the flow nozzle and the thin plate orifice are primary devices from which the static pressure is taken off at two points between which there is a change in cross section and therefore a change in linear velocity. The pitot or impact tube makes use of the difference between the static and kinetic pressures at a single section. The centrifugal device utilizes the centrifugal change of static pressure across a curved stream. The friction meter obtains the loss of pressure, due to friction, through a given length of pipe.

In all these types the secondary element of the meter must, first of all, include a differential pressure gage or two separate gages from which the difference of pressure may be found. It must also contain mechanism for translating the pressure difference into rate of flow, in accordance with the known

TABLE VI-1—CLASSIFICATION OF FLUID METERS

Division	*Class*	*Type*	*Chapter*
		Quantity Meters	
1. Positive	1.1 Weighing	1.11 Weighers 1.12 Tilting Traps	XXII
	1.2 Volumetric	1.21 Tank 1.22 Piston 1.23 Disk 1.24 Rotary 1.25 Bellows 1.26 Wet Drum	XXII
2. Inferential	2.1 Current (Kinematic)	2.11 Propeller 2.12 Anemometer 2.13 Turbine 2.14 Helical	XXIII
		Rate of Flow Meters	
	2.2 Head (Kinetic)	2.21 Venturi 2.22 Flow Nozzle 2.23 Thin-Plate Orifice 2.24 Pitot 2.25 Centrifugal 2.26 Friction	XXIV
	2.3 Area (Geometric)	2.31 Gate 2.32 Orifice and Plug 2.33 Cone and Disk 2.34 Cylinder and Piston	XXV
	2.4 Head-area (Weir)	2.41 Rectangular Notch 2.42 Triangular Notch 2.43 Special Notch	XXV
	2.5 Force	2.51 Hydrometric Pendulum 2.52 Vane	XXV
	2.6 Thermal	2.61 Electric	XXV

Hays Apparatus
The Combustion Compass



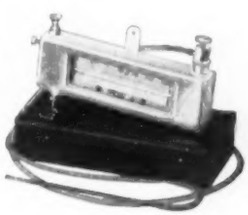
BOILER CONTROL PANELS

We can supply modern steel Instrument panels and all of the important instruments necessary to insure efficient operation and low fuel bills. Combustion Recorders for CO_2, Furnace Draft and Flue Gas Temperature.

POINTER GAGES
for
Draft
Pressure
Differentials
Temperature

Slack Leather Diaphragm Mechanism, no liquids.

TYPE V 3 4 TO 12 SCALES



Inclined Tube Draft Gages
of the portable, pocket type or for permanent mounting.

Portable Combustion Test Sets
consisting of orsat type flue gas analyzers for CO_2, oxygen and carbon monoxide, and gages for draft, pressure and temperature. Various types of test sets and combinations of instruments are offered for consulting engineers, service men and anyone interested in reducing fuel bills.

Check the coupon for literature desired.

☐ Combustion Recorders.
☐ Flue Gas Analyzers and Portable Combustion Test Sets.
☐ Draft Gages.
☐ Treatise on "Handling the Orsat."
☐ Treatise on "Controlling Boiler Operation from CO_2 and Uptake Temperature."

The Hays Corporation
MICHIGAN CITY, IND.

INSTRUMENTS BOOK SHELF

The books reviewed in this section can be supplied by the Instruments Publishing Company.

Radio Frequency Measurements. By E. B. Moullin. J. B. Lippincott Co., New York, 1931. Cloth, 6x9 in., 487 pages. Price $12.50.

This book is intended for those already familiar with electricity in the power field. To introduce them to electricity at radio frequencies, Mr. Moullin does the best thing possible—that is, his very first chapter emphasizes that at radio frequencies all electrical phenomena are so closely involved, they must all be considered together. A current at radio frequencies involves conduction current, displacement current, and electromagnetic radiation. At radio frequencies an inductance includes very considerable capacity and resistance, which must be taken into account at the same time.

Very unlike this is the situation in the power field, where a current is studied as conduction current only, its magnetic field as distinctly a magnetic field alone, so that it becomes a mental habit to consider each electrical magnitude as existing by itself. In arousing the student from this point of view, Mr. Moullin gives the student the correct start toward comprehending the art and science of radio frequency measurement.

As the introduction to a good chapter on resistance measurement is a theoretical consideration of resistance phenomena at high frequencies. This is typical of Mr. Moullin's treatment of capacity and inductance also. First the theory of each electrical magnitude is presented, thus giving the student a basic concept of it. Then knowing the fundamentals, the student can grasp thoroughly the detail methods presented in the rest of the chapter.

An objection can be raised against the content of the book, and it is this: Some branches of radio frequency measurement, in work on which Mr. Moullin has been himself engaged or associated, are very elaborately treated, yet some far more important branches are scantily skimped over. For example, coupled circuit oscillators are extensively treated, but the dynatron and multivibrator are merely mentioned as being in existence. Then also oscillations in coupled circuits—the backbone of radio—is a subject passed over in a half page under "circuit formulae," without even mentioning references for more detailed study. Vacuum tubes, the heart of radio, are gone over in just a few pages, yet "the author's dynamometer ammeter" is treated in complete detail—fully fifteen pages of it.

On the whole, though the book has the limitations just mentioned, it has the far more important advantage that it grounds the reader in the fundamentals of radio frequency measurement, rather than merely throwing at him a mass of information on the subject. Anyone, therefore, with an adequate knowledge of mathematics, and knowing the elements of electricity will find the book a helpful guide into the art and science of radio frequency measurement.—H. Olken.

The Practice of Spectrum Analysis with Hilger Instruments. Compiled by F. Twyman, et al. Adam Hilger, Limited, London, 1931. Cloth, 6x9¾ inches, 53 pages. Price 3s 6d.

This paper is an attempt to sell spectrographic analysis and incidentally the publisher's equipment to all interested in chemical analysis. Very little direct advertising is used, however, only occasional reference to the model of instrument best suited for a particular type of work. Many references to the literature are given in the text followed by a bibliography of 78 publications. The booklet is composed of six chapters which include considerable pertinent and condensed information on all branches of spectroscopy and is well worth its low cost.—C. P. Larrabee.

formula of the primary device, and mechanism for integrating, to give total flow, may also be added.

Area Meters are those in the operation of which a variation of the cross-section of the stream under constant head is used as an indication of the rate of flow. The secondary element of the meter translates the changes of area into changes of rate of flow.

Weir Meters apply only to open conduits, and involve a simultaneous variation of head and area. The secondary device is operated by the change in height of free surface of the liquid.

Force Meters consist of a vane or "obstruction" submerged in the stream, and moved by it against the resistance of a spring or gravity. The secondary device is actuated by the displacement of the vane.

Thermal Meters—The primary element consists of a device for heating the stream of fluid, and a device for measuring the resulting temperature difference. The heat input may be kept constant and the temperature difference allowed to vary with the flow; or the temperature difference may be kept constant and the heat input varied. In the only commercial example the secondary element measures the electrical input for heating, and determines the rate of flow from the known specific heat of the fluid and the known difference of temperature which is maintained constant.

3. Available Methods of Flow Measurement

It is fairly evident from the foregoing that of the eight classes some are more widely applicable than others to the practical measurement and control of fluids in industry. This statement is even truer of the twenty-eight types, of which many are each confined to one particular metering application; and it is made obvious by Table VI-2, classifying the fluids and giving the principal available methods for their measurement. Several of the possible methods are omitted when there is no commercial device of the type known to be used. The table and the elaboration which follows are designed especially for practical use in selecting the proper *class* and *type* of instrument. Where there is a choice of types the final selection must be based on judgment and depend on service conditions in each plant, relative suitability of makes and other details that cannot possibly be discussed here. Practical instructions for installation and use, including the calibration of the instrument, are supplied with all commercial instruments by the manufacturer.

TABLE VI-2—AVAILABLE METHODS OF FLUID METERING FOR VARIOUS FLUIDS AND VARIOUS CONDITIONS OF MEASUREMENT

Fluid	*Condition*	*Class*	*Type*	*Limitations*
Liquids	In Open Channels	Weighing	Weighers	Small Quantities
		Volumetric	Tank	Small Quantities
		Current	Propeller	
			Helical	
		Head	Pitot	High Velocities
		Weir	All Types	
		Force	Hydrometric Pendulum	
	In Pipes	Weighing	Tilting Traps	Small Quantities
		Volumetric	Piston	Small Quantities
			Disk	Small Quantities
			Rotary	Small Quantities
		Current	Turbine	
		Head	All Types	
		Area	Cylinder and Piston	Very Small Quantities
Air and Gases	Free	Current	Anemometer	
	In Pipes	Volumetric	Rotary	Small Quantities
			Bellows	Low Pressure
			Wet Drum	
		Head	All Types	
		Area	Gate	
			Cylinder and Piston	Very Small Quantities
		Thermal	Electric	Cost of Electric Current
Steam	In Pipes	Current	Turbine	
		Head	All Types	
		Area	Orifice and Plug	

NEW INSTRUMENTS

Recently Developed by Manufacturers

Write Information Section, Instruments Publishing Company, for additional Information.

New Automatic Combustion Indicator

The Hays Corporation

THIS new automatic combustion indicator is designed to provide continuous indications of CO_2 content of flue gases, CO_2, furnace draft and flue gas temperature or CO_2 furnace and uptake draft.

The CO_2 analyzing section operates on the well-known Orsat (volumetric-absorption) principle, which has been used for over a quarter century. Water from the regular service line is piped directly to an aspirator, which is an integral part of the machine, and passes into the standpipe. The aspirator draws filtered flue gas from the boiler through the measuring burette, and, rising in the standpipe, traps off a measured sample of gas, places it at atmospheric pressure, automatically compensates for temperature changes, then directs this measured

sample into an absorption chamber filled with chemically wet steel wool. CO_2 is immediately absorbed out, causing a pressure reduction in a metallic bellows which provides ample torque for operating the indicator. The indicator unit is comprised of a closed contact tilting mercury switch, magnetic coil operated brake, and counterweighted free-floating pointer. The mercury switch is adjusted to make contact a moment before the standpipe syphon discharges, thereby releasing the magnetic brake and permitting the pointer to change its position on the scale providing a change of CO_2 content of the flue gases has occurred. Discharge of the standpipe syphon causes the contact to break the electrical circuit. The machine is then ready for another analysis. One analysis is made every 1.9 minutes.

The flue gas temperature unit is a husky dial type instrument operating on the thermo-electric principle. It is mounted on the door of the CO_2 Indicator case as shown in the illustration.

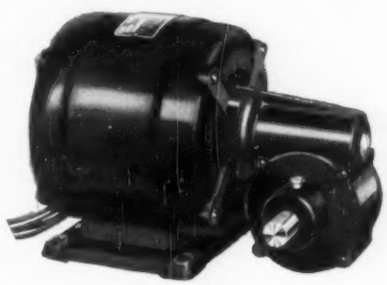
◆◆◆

New Ball-Bearing Motor With Built-in Speed Reducer

Bodine Electric Company

THESE motors are built into a frame which is of three-piece construction with pleasing contour lines.

Gear reductions of 10-1, 20-1, and 40-1 are available, which afford slow shaft



speeds of 28, 43, 56, 86, 112, and 172 r.p.m. at standard motor speeds of 1125 and 1725 r.p.m. The speed reducer consists of a separable nitralloy steel worm and an oversize bakelite gear, mounted in a grease-tight housing forming an integral part of the end shield of the motor.

Double ball bearings absorb the end thrust on the rotor shaft and preserve alignment of the gears after long service. The ball bearings are packed in grease before the motor is shipped and require no further attention for several years. The slow-speed shaft runs in leaded bronze bearings with wool-packed lubrication.

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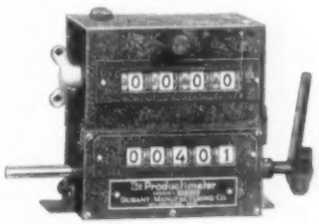
New Pre-Set Counting Machine

Durant Mfg. Co.

THIS counter combines two counting mechanisms in one machine. The first is a pre-determined counter which lights a light, stops a machine, rings a bell, or actuates any other electrical signal at a pre-determined figure, and the second is a continuous run totalizer. An upper dial on this machine shows a row of four white number wheels with black figures, each white wheel adjoining another of metal with black figures etched into it. The metal wheels are set to the desired figure at which the electric switch is to operate while the white number wheels are all at zero. The white wheels show the progress of the individual job count. This row of setting wheels is easily accessible through a door which exposes the top front half of the counter.

The lower half of the counter shows a dial of 5 white number wheels with



prominent black figures. The face of this half of the counter is securely bolted and tamper-proof. This row of figures keeps a continuous running total of the production of the machine to which the counter is attached and enables a close check on over-production or undue waste of any job. It also provides an accurate record of the day's, week's or month's production of the machine.

This pre-determined counter is made with 2 different actions—stroke and rotary. Both types have 4 figures for the pre-determined and 5 figures for the totalizer. In the stroke action the counter can be furnished with the lever at either end of the machine; in the rotary the shaft extends from the rear and can be furnished with either clockwise or counter-clockwise rotation. Both of these types operate on either 110 or 220 volts, either A.C. or D.C. current and have a maximum speed of 400 counts per minute. They are small and compact with an outside case dimension of 4½"x2⅝"x4½" and weigh but 6 lbs.

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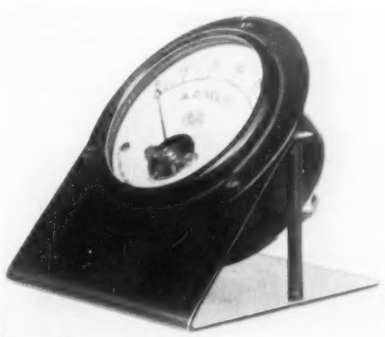
New Mounting Base

Roller-Smith Co.

THIS MOUNTING base is so arranged that it is possible to mount on it any metal or bakelite encased, flush model, Type TA, TD, or TW instrument.



The instrument is mounted on the base and attached to it by two small screws. When the instrument has an external resistor or shunt, these can not be mounted on the mounting base but must be used separately.

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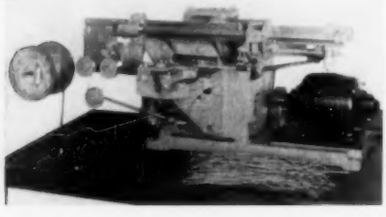
Wire Measuring, Cutting, and Stripping Machine

Artos Engineering Co.

THIS IS a bench-mounted machine, used in electrical industries for automatically measuring, cutting off wires to pre-determined lengths, and stripping off the insulation on one or both ends in



a single operation. The machine requires an operator only for starting new reels and removing cut, stripped, wires. It is suitable for practically all types of single conductor wires, parallel cords, heater cords, service cords, etc.

The change from one cutting length to another is very simple, and requires the adjustment of one lever only by means of an adjusting nut. The stripping length is adjustable from a minimum of ⅛" to a maximum of 1½" on either end. The new machine is primarily designed for short cutting lengths up to 15"; however, attachments can be supplied whereby maximum cutting lengths of 30", 45", 60", and 90" can be obtained. The production capacity for lengths up to 15" is 3000 pieces per hour; for longer lengths the capacity varies from 1500 pieces per hour between 15" and 30" lengths and down to 500 pieces per hour for lengths from 60" to 90". The machine will handle all sizes of wire up to No. 12 B & S gauge, or heavier, if insulation does not adhere greatly to the wire.

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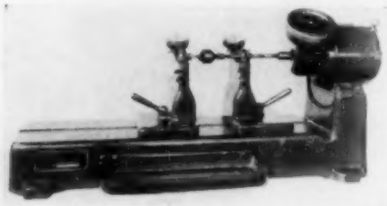
Sensitive Dynamic Balancing Machine

Globe Tool & Engineering Co.

THE SPECIAL purpose for which this machine is designed is to provide a sensitive, accurate, balancing machine for high speed rotating elements, particularly the armatures of small series



motors. A unique feature is the use of a neon light to locate the unbalance spot. The neon light used is similar to the light used on regular stroboscopes.

The unbalance force is found electrically, using only one direction of rotation. It is claimed this reduces by half the time usually required for taking readings. The amount of unbalance is indicated automatically at the time the location of unbalance is taken, which further saves time in determining the state of unbalance.

The manufacturers state that on average small work, such as armatures of series motors for vacuum cleaners, electric drills, etc., the time of making the reading is approximately thirty seconds. This reading includes the magnitude of unbalance on both sides of the work to be balanced, as well as its location.

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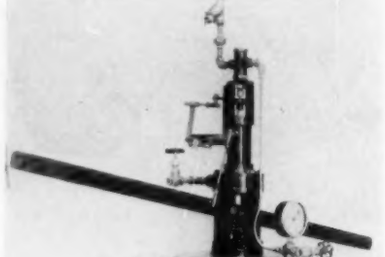
Combustion Control Regulator

Morey & Jones, Ltd.

WHERE it is desirable to vary control equipment in direct relation to pressure changes, this regulator is adaptable.

A spring is set to balance the desired



boiler pressure, exerted on a diaphragm. As the boiler pressure increases above this point, water or compressed air from a constant pressure source is admitted to exert pressure on a regulator-operating diaphragm. The arrangement permitting the compressed air or water to operate the regulator-moving diaphragm is regenerative in action: That is, once the compressed air starts to flow, the flow automatically increases itself till enough force is built up to move the diaphragm and operate the regulator.

Adjustment features are provided so the regulator can handle pressures from 2 lbs. to 500 lbs., and the regulator stroke can be varied over a wide range.

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Combustion Safety Control

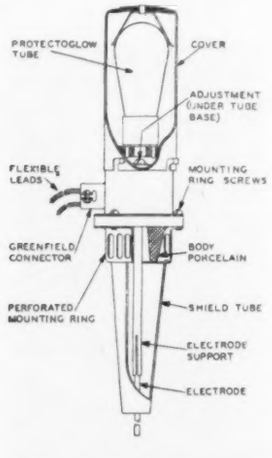
Minneapolis-Honeywell Regulator Co.

A RADICALLY different type of combustion and pilot safety control has just been put on the market. It is known as the Protectoglow. Its purpose is to provide safety on automatic or semi-automatic gas and oil burning systems.

Operation of the device depends on the principle of flame ionization; a minute electric current is passed through the flame itself. The Protectoglow is entirely electrical, and its response to the absence or presence of flame is immediate. Thus there is a sharp distinction between the Protectoglow and any device depending for operation on the heat or light of the flame. Its time lag is practically negligible, regardless of heat absorption, radiation, or incandescent refractory—a feature of vital importance on the larger installations.

When used as a pilot safety control the device prevents the burner from starting if the pilot flame is not present. In case the pilot flame should fail during operation of the burner, immediate safety shutdown would result. When used as a combustion safety control, failure of the main flame of the burner will result in either immediate safety shutdown, or safeguarded program recycling, depending upon requirements.

The Protectoglow utilizes the grid glow tube, which may be considered as a 3 element neon filled tube. The grid of this tube is connected directly to an electrode of heat resisting alloy extending into the flame. A relay, which handles the electric valves, etc., of the burner, is in the plate circuit of the tube. The electrical arrangement is such that when the grid of the tube is grounded thru the electrode and the flame, the relay closes. When this circuit from grid to ground is broken by flame failure, the relay opens.



The relay to be used with the Protectoglow is known as the Glo-Relay, and completes the control system. Various types of Glo-Relays are available, to meet the various control requirements necessary. In general, a complete control system would consist of a thermostat or pyrometer, Protectoglow, Glo-Relay, and electric valve.

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Relay Pressure Valve

Bailey Meter Co.

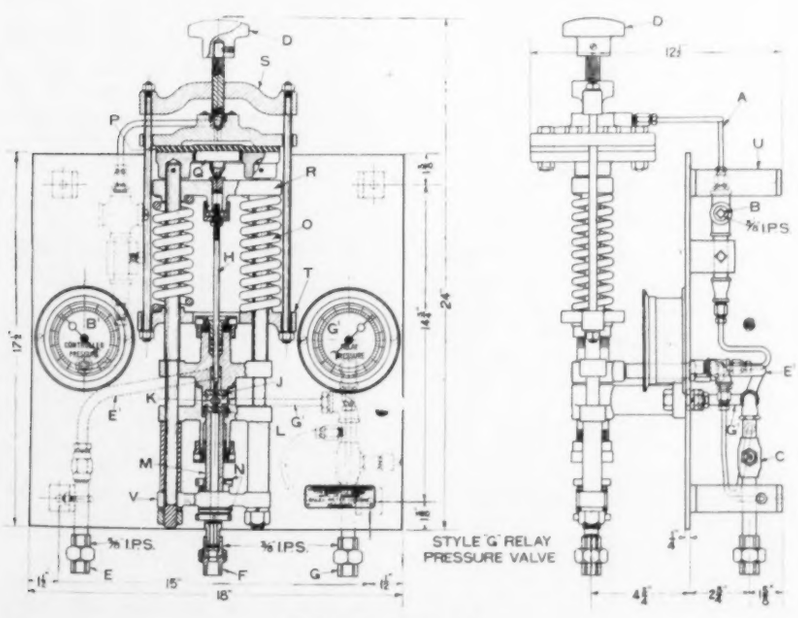
BRIEFLY, the relay valve controls the pressure within close limits by regulating the movement of a syphon operated or piston operated throttle valve installed in the line in which

the pressure is to be controlled. A minute change in the controlled pressure will result in a relatively large change in the motive pressure used to operate the regulating valve.

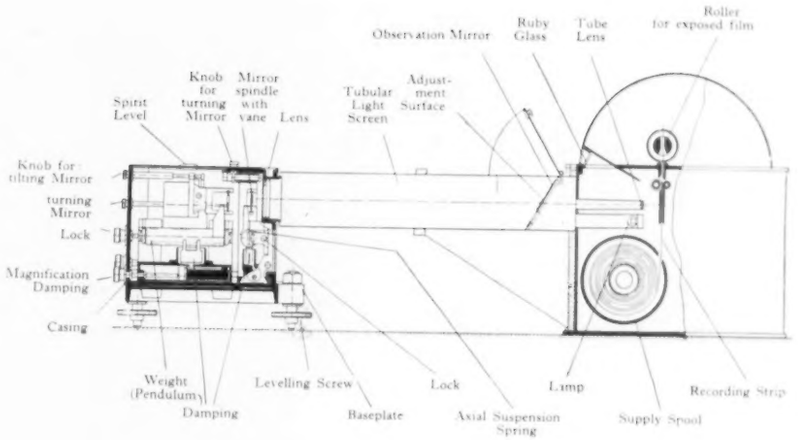
The controlled pressure is connected to point "B" and serves to actuate the diaphragm "P" against the force of springs "O." A motive pressure of air, water or steam at 50 lbs./in.^{2} or over is connected to line "F." Line "G" connects to the sylphon or piston operated regulating valve and line "E" serves as an exhaust. The pressure which exists in line "G" depends upon the position of the diamond valve "K" between the port "L" through which the motive pressure enters and the seat "J" through which the motive pressure exhausts. Assuming that the pressure "B" increases above that for which the relay valve is set, the diamond valve "K" would be moved closer to the seat "L" by the movement of diaphragm "P". This throttles the flow through seat "L" and at the same time increases the port area through seat "J," with a consequent decrease in pressure in line "G," which would in turn cause the main regulating valve to close slightly and bring the control pressure back to normal.

Handle "D" is used to balance the force of springs "O" against the controlled pressure "B" which is indicated on the pressure gage at the left. The relay pressure is indicated by the pressure gage at the right.

Due to an exclusive feature enabling change of the seat gap by adjustment of micrometer adjusting nuts "M" and "N," it is possible to obtain any desired speed or lag in amplified pressure connection "G." The application of this valve is unlimited as it can operate one valve or a series of valves or pistons.



Relay Pressure Valve



Three Component Vibrograph

Three Component Vibrograph

American Askania Corporation

THIS instrument was designed for the study of mechanical vibrations, particularly vibrations of structures. A special feature is that the vibrations are converted into visible wave forms by a mechanical-optical arrangement, rather than by use of a cathode-ray oscillograph. To determine the extent and direction of the vibrations, the movement of the ground is broken up into its three spatial components. The 3 pendulum weights in the instrument are therefore so arranged that they are only affected by forces acting in one of three directions at right angles to each other.

When the ground and the spring-supported axis bearings vibrate, the inert mass remains approximately unmoved but describes a rotary movement in relation to the suspension frame. The magnification for each individual component can be altered mechanically in the ratio of 1:10 by connecting the lever, which is rigidly secured at one end to the weight, to the vane on the mirror spindle but at varying radial distances from the latter according to the degree of magnification required.

Further, the amplification of the movement of the ground is optically adjustable by suitably selecting the path for the beam of light. This path can be altered by fitting lenses of varying focal distance. These are supplied with the Vibrograph. Three lenses of 500, 800 and 1200 mm. focal distance are supplied with the apparatus as standard; they are readily interchangeable. With the first, the movements of the subsoil may be magnified from about 125—1250 times; with the second, from about 200—2000 times; with the third, from about 300—3000 times. The optical magnification is common to all 3 components.

The reactions at the connections between the weights and the frame are tuned to give a natural frequency of 5 periods per second for all three components, which is considerably lower than the ordinary frequencies of the vibrations of the ground. The natural vibrations therefore cannot distort the records on the chart. Hence it is possible to make a true record of ground movements having frequencies down to approximately 12 periods per sec. without undue damping and without appreciably affecting the magnification. If the vibrations to be recorded are considerably under 12 periods per sec. the natural frequency can be reduced to aperiodicity by adjustable oil retarders. The apparatus can then be used for recording even very low frequencies, although its sensitivity will be not inconsiderably diminished.

New Simple Illuminometer

Weston Electrical Instrument Corp.

AN instrument has recently been developed which reads illumination intensities with the same ease and facility as reading ammeters and voltmeters. It consists of an indicating instrument and a light target assembled in a portable case. The light target is on the end of a flexible cord so that it may be placed in any position. This light target or searching unit has 2 Photronic Cell units which convert light energy directly into electrical energy without the use of batteries or other auxiliary voltage. They maintain constant output over long periods of time and there is no dark current. The output from the Photronic Cell units is considerable, allowing the use of a rugged portable instrument calibrated directly in foot-candles.

There are 3 ranges on the instrument, namely 10, 50 and 250 foot-candles. A range changing switch is provided for the selection of the desired scale. Other combinations of ranges are being added to the line and will be available shortly. The light target may be placed at a distance from the observer so that shadows and lights reflecting from light clothing will not cause errors in readings. Light may be read from all angles and the light target may be placed in relatively inaccessible places, in show cases, windows, etc. The absorption of light by painted walls, screens, draperies, etc., can be measured directly by turning the light target so that it faces the surface. Readings may be taken quickly and accurately and the time required to make a lighting survey is about 1/10 of that previously required.

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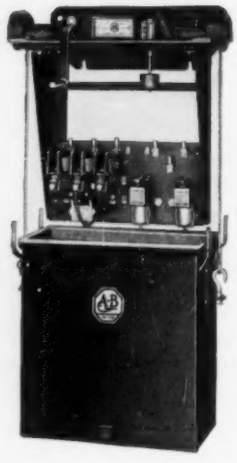
New Explosion-Proof A. C. Starting Switches

Allen-Bradley Company

A LINE of explosion-proof across-the-line starting switches, of both the oil-immersed and air-brake type, are used with squirrel-cage motors and slip-ring motors, on 3-phase or 2-phase 3-wire systems, as well as self-starting single-phase motors, in oil refineries, chemical plants, mines, and wherever inflammable gases or vapors are liable to be present. The maximum



ratings are 25 h. p. at 110 volts, 50 h. p. at 220 volts, and 100 h. p. at 440-550 volts. When used with slip-ring motors, these switches are for primary control only.

The oil-immersed switches are available with ratings of 50, 100, and 150 amperes. The oil tank maintains at least a 6-inch head of oil above the switch panel. In the 100 and 150 ampere switches, the tank is raised and lowered from a cast-iron head by two cable sheaves operated by a handle, allowing one-man inspection. The tank of the 50 ampere switch is so light that sheaves are not provided. The heads are arranged for wall mounting and are equipped with oil-level indicators, as well as having tapped holes for conduit connections.

The air-break type of switch is available only in the 50 ampere size. It is enclosed in a cast-iron cabinet with hinged cover, machined to obtain a tight fit without gaskets. The cabinet is cadmium plated to resist corrosion.

All switches have two magnetic overload relays, and the contactors are equipped with copper-to-copper rolling-type contacts as well as magnetic blow-outs and arc shields. Many types of push-button stations and other accessories for explosion-proof service are available for use with the starters.

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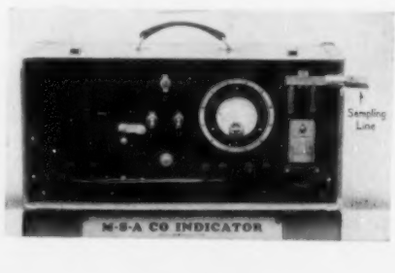
Continuous Carbon Monoxide Indicator

Mine Safety Appliances Company

DESIGNED to test continuously atmospheres in which there is danger of a harmful CO content, this instrument draws a sample of the atmosphere to be tested first through flow-regulating arrangement. The gas then passes into a cell where, by catalysis, CO is converted into CO_2. The heat liberated by this process is proportional to the percentage of CO present, and is measured by a series of thermocouples connected to the indicating meter. The meter is calibrated to read directly in percentage of CO and has a scale range from 0% to 0.15%. The instrument can be designed to indicate as much as 1.5% CO in the air. It is stated by the manufacturer that the accuracy of instrument, for low concentrations of CO, is not affected by the presence of other combustible gases in the sample under test.



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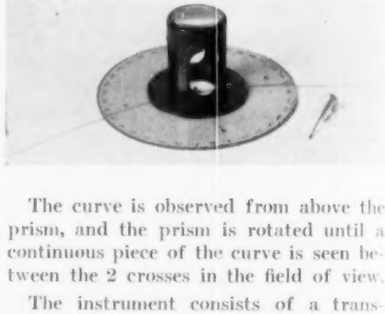
Prismatic Derivator

American Askania Corporation

THIS is an instrument for graphically determining tangents and normals to mathematical curves. It operates on a decidedly different principle from the reflecting deviator, namely the principle that a break in the curve, caused by lateral displacements of 2 meeting branches of a curve, can be recognized better and with less ambiguity than a bend.



The curve is observed from above the prism, and the prism is rotated until a continuous piece of the curve is seen between the 2 crosses in the field of view.

The instrument consists of a transparent circular disc 4¾″ in diameter and divided into 360°. On this there rests the cross-line plate and the prism, mounted in a metal socket. The prism is magnified and the investigation of the curve simplified by a lens which is detachably and rotably fitted on the top. The direction points for tangents and normals are pricked through the cross lines in the cellon disc by means of a special marker which has a centering point.

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Color Matching Machine

Sheldon Electric Corporation

THE Colorscope was invented by Prof. H. H. Sheldon, Department of Physics, New York University. It is a photoelectric machine which operates on the house current and measures the difference in coloring between any two samples placed in it. The difference is measured in percent variation of total intensity of reflected light, and then percent variation through standard filters.

The machine is approximately 2′ wide, 3′ deep and 4′ high. It is enclosed in a strong steel cabinet mounted on wheels so that it can be conveniently rolled from one part of a plant to another.

Machines are made for either a.c. or d.c., and when plugged into a standard house lighting fixture they are ready for operation. In matching textiles, paper and certain other materials 2 factors may enter which might cause erroneous readings. One is weave, texture or grain, and the other is surface sheen. It is claimed the Colorscope eliminates these sources of error; that of sheen by an ingenious system of lighting which completely avoids specular reflection; and the other, by rotation of samples, so that texture in the materials being tested is blended to produce a homogeneous effect. This enables the operator to compare silk with wool, paint with leather or other material, and to read nothing but coloring.

The machine is so constructed as to act in a manner imitating the eye. Fechner's law of the least perceptible difference being proportional to the whole stimulus, is taken into consideration by the mechanical use of an iris diaphragm that keeps the amount of light entering the machine constant regardless of the color of the samples being measured.

In taking readings on the machine 2 samples are placed in it and the needle of the meter brought to 0 by turning a control. The samples are then interchanged in their holders by a mechanical slide. The meter needle then indicates the percentage variation between the 2 samples in total intensity of reflected light. This indication is for quick determination of the matching of the 2 samples. It is meant for the testing of colors in the same family group, i.e., matching 2 blues, 2 grays, etc. It is also employed for determining the difference between batches of gray goods, for testing materials colored with the same dye solution, observing relative strengths of pigments, tinctorial value, bleaching effects, etc.

The Colorscope is also equipped with standard color filters with which one may determine how samples differ in color. When using these, dyers are able to measure the color effects of any dye at a standard concentration, and then by consulting a table, determine the effects of this dye in any other concentration. This enables the operator not only to see if his work comes within the required limit of tolerance, but also which concentration of his dyes may be used for correction.

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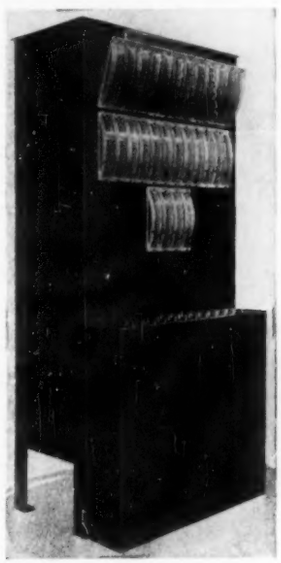
Control Panel

The Hays Corporation

THIS control panel is designed to provide at one central point the necessary number of differential type draft gage units necessary for the proper control of primary air for combustion required in installations of the new large zone control type forced draft stokers as manufactured by The American Engineering Company.



Because of the large number of draft gages required, particularly with the larger sized stokers, a compact gage is necessary in order to reduce space requirements of the panel to a minimum. This has been accomplished in the gages used by providing an air-tight steel case fitted with a soft rubber gasketed molded front for each standard colon leather diaphragm power unit. One connection from the zone orifice is made at the case while the other connection is made direct to the power unit. The differential pressure is thus read direct on the large scale at no sacrifice of visibility.

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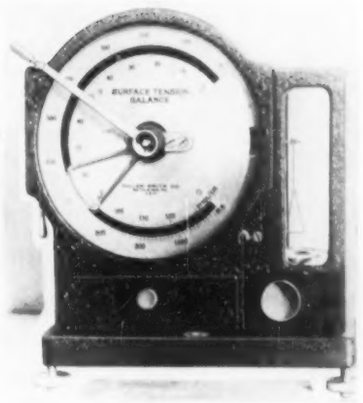
Surface Tension Balance

Roller-Smith Co.

TO MEASURE the surface tension of liquids is the purpose for which this instrument was especially designed. It has a double scale, one reading in



milligrams, the other in dynes-per-centimeter, which is the commonly accepted unit of surface tension.

Essentially the instrument is a 1000 milligram balance with a parallel scale calibrated in dynes per centimeter. It comes completely equipped with the necessary platinum ring, watch glasses, check weights, etc. The instrument has a glass cover which shields the hook, ring, liquid, and stage. A stage is provided for carrying the sample in a watch glass, the stage being raised and lowered by a rack and pinion operated by a knurled knob projecting out in front of the case.

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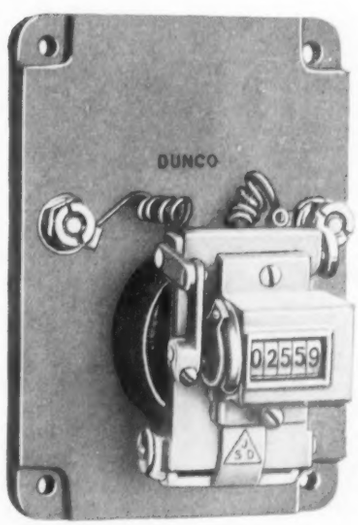
Electrical Magnetic Counter

Struthers Dunn, Inc.

THIS unit is a counter useful for determining the production of a machine at a remote point from the machine. It is also adapted for use for count taken by interrupting the light to a photo-electric cell. In design it is essentially a standard Dunco relay with a counter unit mechanically connected to the relay armature.



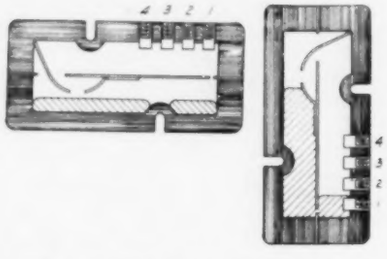
New Time Delay Switch

The Lincoln Electric Company

A NEW time delay switch, unaffected by temperature changes or operating conditions, has been developed.

The operation of this switch may, in a way, be likened to the well known hour glass, since its principle is the slow movement of mercury from one chamber to another. This will be seen in the sketches. The lower sketch shows the switch in the off position with the mercury in the lower chamber.

Wire connections are tapped to the upper compartment. In the upper view the switch has been turned and the mercury has begun to flow into the other cavity through a small opening. As this mercury rises it completes the circuit at the various taps. By changing one connection to the different taps, of course a variation in time delay is secured in each switch. For example, with one connection to tap No. 1 and another to No. 2, a certain delay is secured. Now change one connection to tap No. 3 and a longer delay is secured as it takes longer for the mercury to rise that high. By varying the size of the small opening at the bottom the switch can be manufactured to give almost any time delay desired.



When the switch is turned off—that is, when it resumes its horizontal position—the mercury passes through a large opening into the lower chamber and the switch is ready to be used again as contact is broken immediately.

This device is mounted in connection with the contactor switch so that when this main switch goes in the delay switch is changed immediately to a vertical position, and vice versa when the main switch is thrown off.

This type of switch can be built for a time delay of 2 to 20 seconds. Totally enclosed, it is not affected by temperature variations, dust or other harmful atmospheric effects. It can be used in a number of applications; at present it is built into the Lincoln automatic induction controller.

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Epiphot

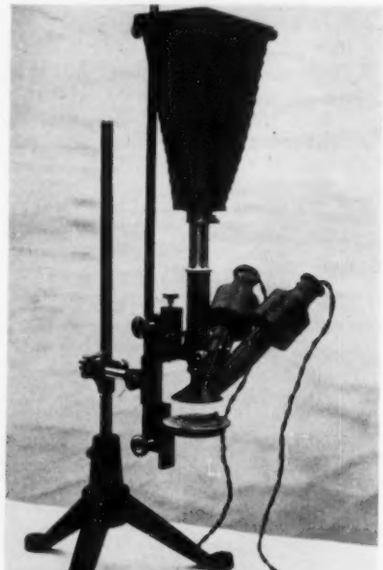
Clay-Adams Co.

THE EPIPHOT is designed for the projection, photography and ocular examination of opaque objects under varying magnifications. Useful in such industries as textile, leather, metal, chemical wherever examination of opaque objects is desired.

The illustration shows that the apparatus consists of a microscope with a built-in double illuminating system which illuminates the opaque object under examination on the stage.

The apparatus has a coarse and fine adjustment screw for the focusing. The stage is revolvable and is raised and lowered by rack and pinion. This allows focusing without moving the illuminating system. 7 × Objective (23mm.) and 5 × Ocular are supplied with the apparatus. Any standard microscope objectives or oculars may be used and interchanged. The rheostat which is supplied is suitable for both 110 and 220 volts and both direct and alternating current.

The entire instrument is mounted on a heavy tripod base by a horizontal and vertical rod making it possible to turn the apparatus through a range of 360° both about the vertical rod and about its horizontal rod as an axis.



For making accurate photo micrographs of opaque objects a specially constructed camera attachment is used (which is supplied with the apparatus). This attachment is equipped with bellow, ground glass, plateholders, iris diaphragm, photographic shutter with wire release for time bulb and instantaneous exposures. A metal bracket secures the camera firmly to the supplementary rod. A light tight sleeve fits over the ocular.

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Circuit Tester

Roller-Smith Co.

THIS instrument can be used to ascertain if there is an electrical circuit existing between conductors applied to the terminals of the instrument, and if such a circuit exists, its resistance is indicated on the scale. The circuit tester therefore performs the same function as magnetos and a.c. bell ringing devices, over which the following advantages are claimed for it.

In the first place, it is much smaller and more compact, measuring only 4½" x 3" x 1½", and weighing only 19 ounces. Also, the instrument will not mislead by giving an indication when only capacity exists between the conductors to which it is connected—though this is likely to happen with magnetos or other circuit testers using alternating currents.

Resistance is read directly in ohms on the scale of the instrument. Embodied

in the instrument is a small dry cell in series with a high (10,000 ohms) resistance galvanometer. Because of the low current consumption of the instrument, the battery should give service for many months. From time to time the condition of the battery can be determined by short-circuiting the terminal posts, which should give full scale deflection of the pointer. An adjusting screw is provided whereby falling off in battery voltage can be compensated for.

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Proportioning Electric Motor Control System

Minneapolis Honeywell Co.

PRACTICALLY all motor-operated valve control systems heretofore have been of the "off and on" type, or more or less elaborate modifications of it. The effort, where these modifications have been used, has been to attempt, usually through forms of step control, to effect continuity of supply of heat to meet variations in demand. However, if temperature, for example, is to be controlled accurately, heat must be supplied not only continuously but the B.t.u. supply must also be graduated or modulated in proportion to the demand.

Proportioning implies a constant ratio. Consequently, if we assume that the movements of a damper, for example, are graduated so that its degrees of opening are equivalent to temperature

variations, we will have established the mechanical analogue. The Minneapolis-Honeywell Proportioning Control does this through the medium of electrically controlled units. Fundamentally, the apparatus incorporates a combination of two parts, namely the electrical transmission system and the associated power unit which can be adjacent to or remote from the controlling instrument. A mechanical interconnection is required between the power unit and the electrical balancing mechanism. The transmission system operates on the Wheatstone bridge principle.

The power unit causes its drive shaft to take a new position whenever the condition under control, such as temperature, changes slightly. If a device such as a valve, or if valves, louvers or rheostats are driven by the motor, then their operation tends to correct the change and a condition of equilibrium is approached.

The apparatus may be used in conjunction with practically all types of control instruments such as temperature controllers of the expansion type, pressure controllers, pyrometers, certain types of flow meters, etc. Existing instruments require slight modifications to make them applicable but the revisions usually are simple.

The apparatus is capable of being produced in almost any size, from small, compact, totally enclosed integral units of small motors and associated receiver mechanisms, to units using powerful motors capable of operating heavy loads.

The motor operates only when a change of position is demanded by the controller. Then the driven devices are moved immediately to a new position and remain there until conditions again change. This means that the demand for electrical energy occurs only during the repositioning period whereupon the motor starts in either direction with maximum torque available to move the driven device to a new position. This mode of control has certain points of similarity to that of standard air-operated automatic control systems. A significant difference is found in the fact that demands for movements irrespective of any former positioning finds the motor ready to respond instantly with full torque. With

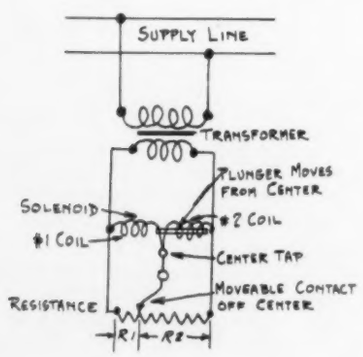

Fig. 1

the pneumatic system, air pressure must be built up in the diaphragm valve in order to create sufficient force to move its associated mechanism from one position to another. This causes lag, which increases as the resistance to mechanism movements becomes greater. Hydraulic and steam-powered control systems are in general not unlike the air-operated ones in these respects.

With the proportioning Motor Control System, moreover, the extent of corrective action for a given deflection of the instrument may be made as great or small as desired. This response may be made to vary automatically with relation to the existing and the desired condition. For example, if temperature is being controlled and it is increasing to the desired value, at a predetermined point below that the commanded valve will immediately assume, say, a half-open position. From this point on, as the temperature rises towards the desired one the valve will move in progressively smaller steps until the temperature reaches the desired point. This relation, motion as a function of temperature, may be made to suit practically any condition. Therefore, equilibrium between temperature and rate of heating medium supply may be arranged to occur at any fractional opening.

Operating Principle—Consider first a solenoid having within it a plunger which is free to move, the plunger being shorter than the coil. When voltage is applied to the coil the plunger, of course, will move to the center, *i.e.*, its position will coincide with the magnetic center of the solenoid. Upon dividing the coil of the solenoid into two halves and connecting the center tap to a contact positioned at the center of resistance in parallel with the solenoid, the plunger will be unaffected.

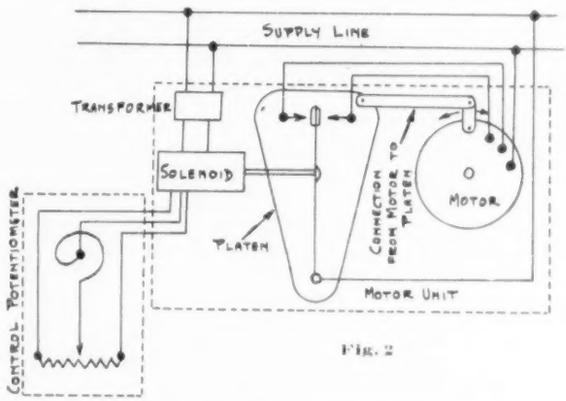

Fig. 2

Now, if we move the contact to the left as shown in Fig. 1, then R_1 becomes smaller and R_2 increases. Consequently, less current flows through coil 1 and more through coil 2; the magnetic center of the solenoid coil moves to the right, and the plunger follows to the right until its center coincides with the magnetic one. Hence, if the plunger is properly designed as to length, etc., its position will at all times be proportional to that of the contact movable along the resistance.

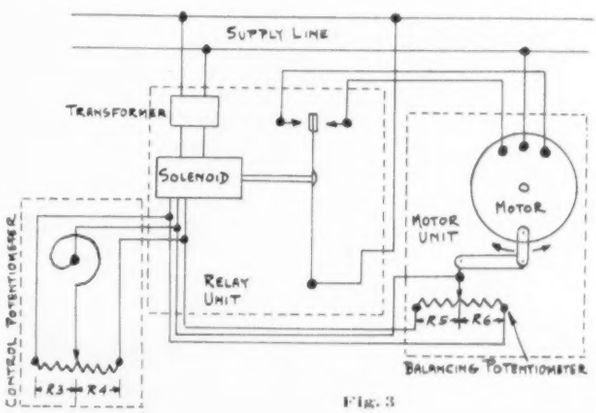

Fig. 3

A valve-operating follow-up mechanism is provided, which is in operation only when the plunger changes position. It then positions the valve in correspondence with the new position of the plunger. The circuit for this control-operating follow-up in shown in Fig. 2.

A modification of this follow-up mechanism for operating the control motor at a distance from the plunger is shown in Fig. 3. Outside view of the device is shown in Fig. 4.

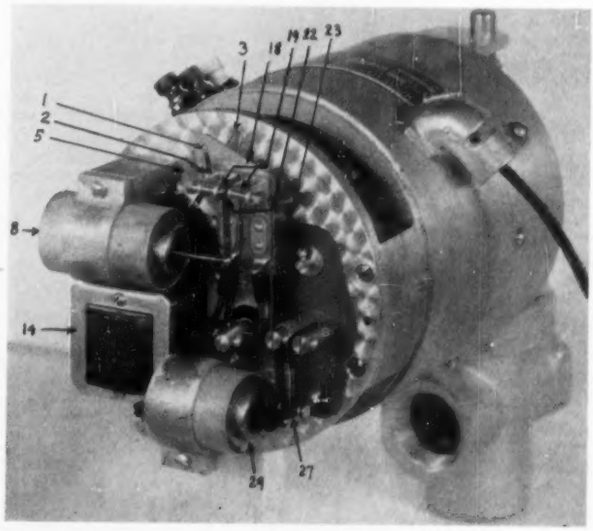

Fig. 4

MANUFACTURERS' LITERATURE

In this department we each month list the printed matter issued by manufacturers. Unless otherwise noted, any of the items listed may be secured free upon application to the issuing firm. Manufacturers who have not yet sent in their printed matter are invited to do so.

11 Motors. Bulletin 208 describes slow speed torque motors or rotating magnets. These motors may be wound for any voltage up to 550 for 2 or 3 phase A.C.; or for D.C. up to 250 volts or for single phase A.C. up to 220 volts. The Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio.

12 Stroboglow. A folder describing a stroboscope designed primarily for the study of high speed rotating or vibrating objects. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

13 Testing Machine. A reprint from "The Melliand," Vol. 1., No. 11, February, 1930, entitled "The Duplan Cohesion Testing Machine." Geier & Bluhm, Inc., 670 River St., Troy, N. Y.

14 Gas Service Journal. December, 1931, issue contains the articles, "Modern Pressure Regulation," "The Emcorector on Industrial Measuring Installations," etc. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

15 Oscillographs. A booklet describing the cathode-ray oscillograph adaptable to the factory or field as well as to the laboratory. General Electric Co., Schenectady, N. Y.

16 Electrical Instruments. Catalogue GEA-602A furnishes information on standard lines of switchboard, portable and laboratory instruments. General Electric Company, Schenectady, N. Y.

17 Machine Shop Practice. A 216 page handbook illustrated and replete with data on gages, small tools, fixtures, special machines, and machine shop practice. The Taft-Peirce Mfg. Co., 32 Mechanic Ave., Woonsocket, R. I.

18 Water Works Journal. The November, 1931, issue of this publication features the following articles: "The Public and the Utilities"; "Hydraulically Speaking," etc. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

19 A. C. Portable Instruments. Bulletin No. 160 describes alternating current portable instruments; type GSA ammeters, voltmeters, volt-ammeters, single and polyphase wattmeters, etc. Roller-Smith Co., 233 Broadway, New York.

20 Recorder Controller. Catalogue No. 4001 describes a new development in free vane air operated recorder controller. The Bristol Co., Waterbury, Conn.

21 Valves, Manometers, Indicators. Bulletin No. 206, Duplex Control Valve Unit; No. 207, High Pressure Manometer; No. 208, Flow Indicator, and No. 209, Orifices and Orifice Flanges. Morey & Jones, Ltd., 922 S. Hemlock St., Los Angeles, Calif.

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INSTRUMENTS, 3619 Forbes St., Pittsburgh, Pa.

Please have me supplied with a copy of each piece of Manufacturers' Literature listed below.

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Name.....

Position.....

Firm.....

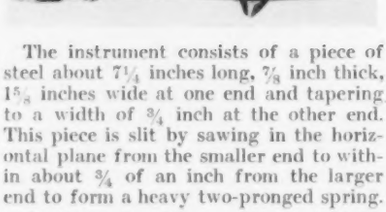
Street and No.....

City.....State.....

Portable Brinell Hardness Tester

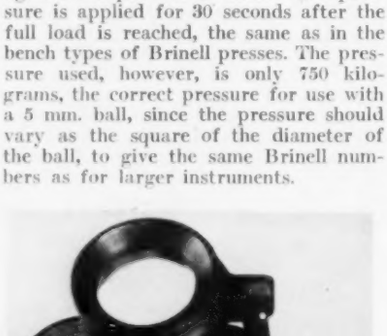
R. Y. Ferner Co.

A NEW hardness testing instrument, designated as a Dwarf Brinell Press, is based on the Brinell principle of making an impression on the metal to be tested by applying a known load to a steel ball of a given diameter. The instrument is portable, however, and can be used anywhere in the shop where a drill press or arbor press, a vise or a heavy C clamp, or other means of applying pressure, is available.



The instrument consists of a piece of steel about 7¼ inches long, ⅞ inch thick, 1⅝ inches wide at one end and tapering to a width of ¾ inch at the other end. This piece is slit by sawing in the horizontal plane from the smaller end to within about ¾ of an inch from the larger end to form a heavy two-pronged spring.

On the under side, near the end of the slit, is mounted a holder for the steel ball which is of 5 mm. diameter. Opposite this, on the upper prong, is a knurled knob to which the pressure is applied. In making a test the instrument is held in the drill press or between the jaws of the vise or C clamp with the ball point against the piece to be tested. The pressure is applied for 30 seconds after the full load is reached, the same as in the bench types of Brinell presses. The pressure used, however, is only 750 kilograms, the correct pressure for use with a 5 mm. ball, since the pressure should vary as the square of the diameter of the ball, to give the same Brinell numbers as for larger instruments.



The whole outfit is supplied in a polished wood box 8½x5x2 inches. The weight of the two-pronged steel piece is 2 pounds and the whole outfit weighs only 3 lbs. 9 ozs. It is, therefore, distinctly a portable outfit which can readily be carried to any part of the shop or used on field inspection trips.

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New Recording Absolute Pressure Gage

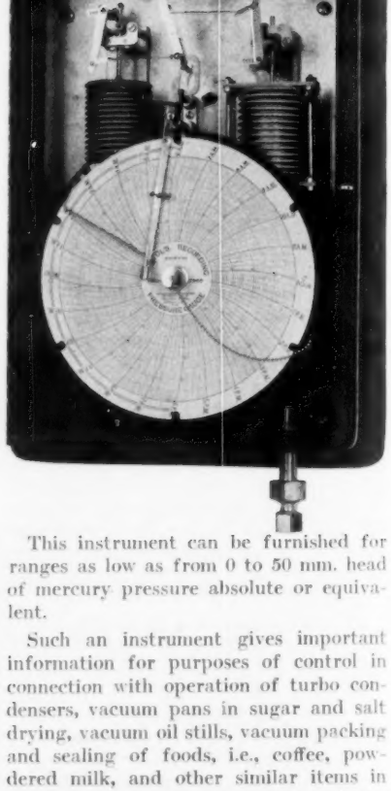
Bristol Company

IN THE control and operation of apparatus that relies on the maintenance of a high and constant vacuum under all conditions, it is necessary to correct all such vacuum readings as indicated or recorded, by reference to a barometer. This is inconvenient when the need for these corrections become continuous.

Since there can be no control of variations in barometric pressures, there is a need for a vacuum gage which automatically compensates for barometric pressure changes.

When a high reading vacuum gage is compensated for barometric pressure changes, it becomes in actual use a low range absolute pressure gage. This new instrumert is a direct reading, single pen, absolute pressure gage of the recording type. It fills a long acknowledged need in the present "state of the art" of pressure measurement.

The use of high vacuum is an important factor in many production processes. This instrument now offered eliminates any possibility of confusion or delay, resulting from applying barometric corrections to vacuum readings.



This instrument can be furnished for ranges as low as from 0 to 50 mm. head of mercury pressure absolute or equivalent.

Such an instrument gives important information for purposes of control in connection with operation of turbo condensers, vacuum pans in sugar and salt drying, vacuum oil stills, vacuum packing and sealing of foods, i.e., coffee, powdered milk, and other similar items in cans, vacuum retorts in chemical plants, the manufacture of gaseous type vacuum tubes, and similar devices.

The actuating mechanism consists of 2 extremely sensitive diaphragm elements. One is connected to the vacuum line, and the other is directly affected by barometric pressure variations. The resulting movements of these elements are transmitted by a differential transmitting linkage to a single pen arm which permanently records on a suitable chart.

The case for housing the instrument is all metal, attractive in design, and of rugged construction. It is available for surface or flush mounting.

INSTRUMENTS ABSTRACTS

Abstracts on instruments and devices for measurement, inspection and control.

INSTRUMENTS ABSTRACTS, incorporated in INSTRUMENTS, is the most complete review on the subjects of measurement and control.

Abstractors cover over 500 domestic and foreign publications.

Upon receipt of the abstracts they are checked against permanent files to avoid duplication and after being rewritten to conform to our style they are classified.

Oftentimes an abstract can fit under two or even more sections. In that case we decide who will be most interested in the article, and include it under that field of reader interest. It is our aim to so arrange the abstracts that a person interested, for example, in viscosity, will keep in touch with all the important articles in his field if he reads only section 2.10. For instance, an article on "Vacuum Tube Means of Measuring Viscosity" appears under 2.10—under "Measurement and Control of Physical Properties—viscosity," although it would also fit under section (5.4)—"Electronic Devices and their Applications."

An improvement we hope to make in the Abstracts Section in the near future is the cross-indexing of articles which fit under several sections. We suggest glancing through the whole Abstract Section. This taken but a short time, and the time so taken will be found very profitably spent.

The classification number at the end of each abstract will be of assistance in mounting them on file cards.

Negative print photostats of the original articles abstracted can be obtained at 35 cents per page plus 10 cents for mailing. The remittance should accompany the order.

CLASSIFICATIONS

(By Fields of Reader Interest)

MEASUREMENT TECHNOLOGY (1)
This section includes all matters concerning the art and science of measurement as follows:
Measurement Theory (1.1)
Under this heading will be included: definitions, precision of measurements, systems of units, and dimensional analysis.
Measurement Practice (1.2)
Covers Calibration and Standardization.
Calculation (1.3)
This does not include computation for instrument design, but covers calculations as a mode of measurement.

MEASUREMENT and CONTROL (2)
This section is devoted to those general measurement practices and control applications that are not confined to any one industry or branch of engineering. Thus temperature measurement and control, being of as much importance in chemical as in metallurgical processes, is a general field of interest to all industries and all branches of engineering.
Length, Angle, and Area, Including Surveying (2.01)
Time, Speed, and Acceleration (2.02)
Weight, Density, and Specific Gravity (2.03)
Pressure and Vacuum (2.04)
Flow and Volume (2.05)
Temperature (2.06)
Heat and Combustion (2.07)
Humidity and Moisture (2.08)
Power, Work, and Output (2.09)
Physical Properties, (Viscosity, hardness, elasticity, plasticity, surface tension, etc.) **(2.10)**

TESTING and INSPECTION (3)
Physical Testing and Inspection (including strength tests, bending, magnetic analysis, X-ray inspection, and other engineering test or inspection methods.) **(3.1)**
Production Testing and Inspection (This includes methods of testing and inspection for setting up production standards, grading, gaging, maintaining quality, etc.) **(3.2)**
Maintenance Testing and Inspection (Included here will be matters concerning standards and methods for controlling performance or service of equipment. Example—The problem of controlling long phone lines to give quality sound transmission would be included here.) **(3.3)**

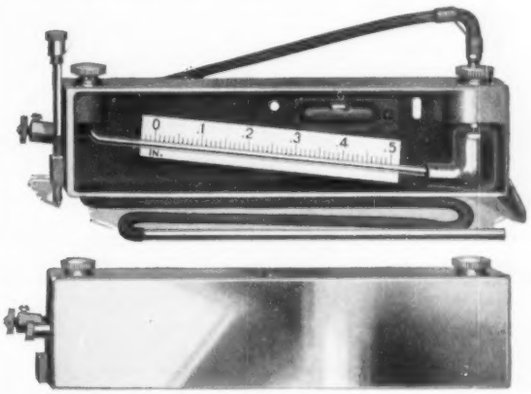
ELECTRICITY and MAGNETISM (4)
Electrical Properties, Tests, Measurements, and Measuring Instruments (4.1)
Electrical Measuring Devices and Applications (4.2)
Magnetic Measurements (4.3)
Magnetic Properties Materials, and their Applications (4.4)

ELECTRONICS and RADIO (5)
Radio Measurements (5.1)
Applications of Radio to Measurement and Control (5.2)
Photo-electric Measurements, Devices and Applications (including television) **(5.3)**
Electronic Measurements, Tubes, Devices, and their Applications (Under this heading would be included thermionic tubes, grid-glow tubes, thyratrons, neon discharge tubes, cathode-ray tubes, etc.) **(5.4)**

ACOUSTICS and VIBRATIONS (6)
Sound, Vibration, Phenomena and Measurements (6.1)
Sound and Vibration Devices or Applications (6.2)

The New

Ellison Draft Gage Set



IN this new type portable set the gage case is of aluminum with chromium plated steel cover for the carrying case, embodying simplicity, compactness and durability. It is the product of 35 years of original improvements in manufacturing draft gages of outstanding accuracy, design and construction. Made in scale ranges from ½ to 2" completely equipped.

New Bulletin Fifteen "How to Use a Draft Gage in Domestic Heating Plants" describes this Set

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Casing of Armco Iron Duco Finish

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1"
1.4"
2"
5" scale
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THIS dial type gage is by far the most outstanding value in draft gages produced. It has a powerful bell movement on three knife edge bearings—permanent zero. Accurate and durable like all Ellison gages.

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3-Pointer 8-9-10" scales .6 up to 6" range	75.00

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214 W. KINZIE STREET CHICAGO

LIGHT, OPTICS, and RAYS (7)
Light—General Measurements and Optical Applications (7.1)
Color Analysis, Color Matching (7.2)
Photometry (7.3)
Polarimetry (7.4)
Spectrometry (7.5)
Photography (7.6)
Microscopy (7.7)
Electromagnetic Rays (This heading covers all electromagnetic rays other than visible light: infra-red, heat rays, ultra-violet, X-rays, alpha, beta, gamma, cathode, and cosmic rays.) **(7.8)**

CHEMISTRY (8)
Under this heading will be chemical measurements, analysis, and their control applications.

ASTRONOMY, NAVIGATION, AVIATION (9)
Included in this section will be, besides usual matters concerning astronomy, navigation and aviation, special matter on direction-control such as range finding, direction finding, radio beacons, etc.

GEODESY, GEOLOGY (10)
In this section will be covered seismology, geophysical prospecting methods, etc.

INSTRUMENT DESIGN and CONSTRUCTION (11)
Matters concerning new instruments, their design, operation and manufacture, will be included under this heading.

GENERAL and MISCELLANEOUS (12)
This section will include: First; general items of interest to all in the field of measurement and control. Example—"Possibilities of Vacuum Tubes for Application to Measurement and Control" is an article of universal interest in the fields of measurement and control. Second; miscellaneous items of general interest because not includable under any of the above classifications. Finally, items of general interest to all fields of measurement and control, such as historical material, biographical, etc.
General (of interest to all in measurement or control fields) **(12)**
Miscellaneous (12.2)
Historical and Biographical (12.3)
Bibliographical (12.4)
Economic (12.5)

CONTROL FUNCTIONING EQUIPMENT (13)
Literature on the equipment used by operators or automatic controllers to perform their control functions will be covered under this heading. For example, the drum controller and associated switches, rheostats, relays, and motor starters by which an operator controls the motion of a crane are all pieces of "control functioning equipment."
Mechanical Control Functioning Equipment (13.1)
Electrical Control Functioning Equipment (13.2)
Includes drum controllers, relays, solenoids, etc.

◆◆◆◆◆

MEASUREMENT TECHNOLOGY (1)

Measurement Practice (1.2)

On the Determination of Periodic Errors of Screws. (Ueber die Bestimmung periodischer Fehler von Messchrauben.) A. Kohlschuetter, Zeitschrift fuer Instrumentenkunde, Vol. 50, June 1930, pages 370-374.
Author developed a new method with the object of eliminating the errors due to the strokes of the scale. E.F. (1.2)

Gas Meter Calibration by Means of the Mariott Bottle. (Gasmesser Eichung mit Mariottscher Flasche.) L. Zipperer, Gas & Wasserfach, Vol. 74, Jan. 10, 1931, pages 27-28.
The formulae for the measurements are derived, the advantages of the testing method clearly pointed out, and the accomplishment of measurements of this kind is demonstrated. E.F. (1.2)

Proposal for Determining the Absolute Accuracy of Adjustments on Electrical Pointer Instruments. (Vorschlag zur Bestimmung der absoluten Einstellsicherheit von elektrischen Zeigerinstrumenten.) W. Oehlerking, H. Krauss & A. Griesbach. Zeitschrift fuer Instrumentenkunde, Vol. 51, April 1931, pages 205-207.
Pertains to the determination of the friction moment. The utilization of the method is demonstrated by check readings on 2 instruments. E.F. (1.2)

MEASUREMENT AND CONTROL (2)

Length, Angle and Area, Including Surveying (2.01)

Weighing Thin Sheets to Measure Thickness. F. V. Hartmann. Machinery, Vol. 37, Feb. 1931, pages 430-432.
Metal sheets of Al 0.00025 in. thick were weighed to determine their thickness because they could not be measured exactly enough. A special press was developed to cut the specimens so accurately that the error in weighing them for the calculation of the thickness is negligible. Ha. (2.01)

The 27.5 cm. Hildebrand Screw Microscope Theodolite for the Basic Triangulation. (Der 27.5 cm. Hildebrand Schraubenmikroskoptheodolit fuer die Haupttriangulation.) K. Luedemann, Zeitschrift fuer Instrumentenkunde, Vol. 50, Sept. 1930, pages 530-539.
Reviews the development of the horizontal angle measurement in triangulation and describes the latest design of the theodolites used for this purpose; bibliography included. E.F. (2.01)

(Continued on Page A21)

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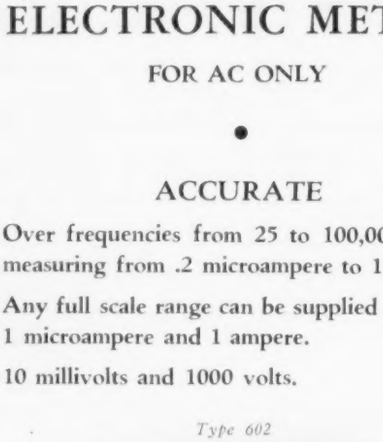

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Of instruments and devices for measurement, inspection or control

If you are unable to find what you require in this section of INSTRUMENTS—write Information Section, Instruments Publishing Company. Give complete information of requirements.

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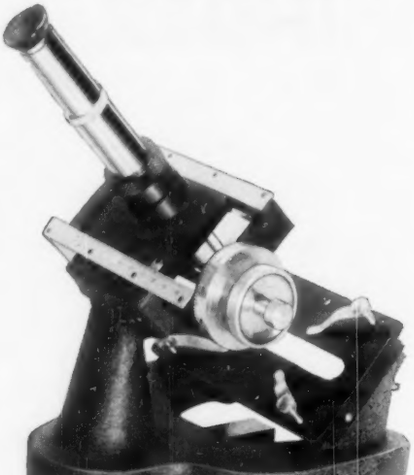

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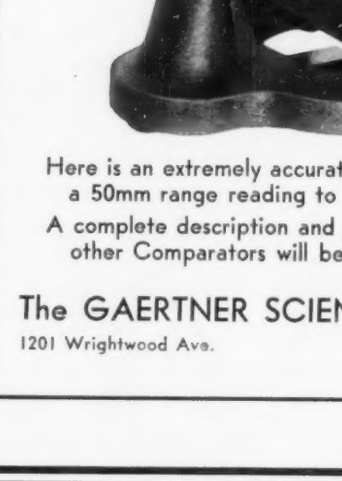

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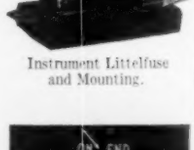

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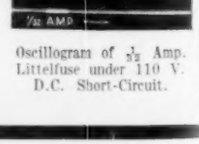

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(Continued from Page A14)

Light-ray Indicator for Mapping of Angular Values. (Licht strahlzeiger zur Kartierung von Winkelwerten.) Leonhardt. Zeitschr. Verein deut. Ingenieure, Vol. 75, July 18, 1931, page 945.

The Askania-Works, Berlin, have developed an apparatus which facilitates the location of a desired point of the earth's surface (f. i. in case of forest fires, SOS-calls of ships, etc.). It consists of two or more devices about 25cm. high, similar to little light-houses, containing a lamp in the upper part and mirror under 45°/ in the lower part; over the mirror a black wire is extended which throws a thin shadow line of about 1.5m. length over the map on which the device is installed. As the latter can be turned around their vertical axis the line is adjusted in the direction of the angle found by observation; the intersection of the shadow lines gives then, with great accuracy, the point to be located. Ha. (2.01)

Surveying Instruments, Their Uses and Abuses. L. C. Higbee. The International Blue Printer, Vol. 4, Dec. 1931, pages 10, 28.

Modern speed and rough handling are considered to be the reason for most of the deterioration of comparatively sensitive instruments such as these instruments actually are. Even the best materials and construction methods available by modern technique will not be able to compensate for abuses. Ha. (2.01)

Surveying Rods for Height Measurement Without Calculation. (Höhenmesslatten ohne Rechnung.) Lips. Zeitsch. Vermessungswesen, Vol. 60, Aug. 1, 1931, pages 458-466.

A few types of surveying rods are described which have a fixed and a movable division. Adjusted to a certain fixed point, measurements can be read directly. An example illustrates the method which offers great economy in time and field expenses as is shown on three different surveys. Ha. (2.01)

The Knife-edge or Hatchet Planimeter. F. B. Haynes and L. C. Haynes. Review of Scientific Instruments, Vol. 2, July 1931, pages 396-400.

The theory and construction of an extremely simple planimeter are developed. It consists simply of an arm of adjustable length bent at both ends vertically, one leg being given the form of a point which follows the outline of the curve to be planimetered, the other having a circular or curved edge. The area measured is then $A = \pi a^2 \varphi/120$, where φ is the angle between the two extreme positions of the edge during one course around the curve, and a is the length of the instrument. Ha. (2.01)

Thickness Measurement Under the Microscope (Dickenmessung unter dem Mikroskop.) K. John, Zeitschrift fuer Instrumentenkunde, Vol. 50, Nov. 1930, pages 638-645.

The author arrives at the conclusion that an exact thickness measurement under the microscope is impossible at the present. The harmful influences cannot entirely be eliminated. A check reading on the same sample by a further testing method is therefore suggested by the author.
E.F. (2.01)

An Instrument for Measuring Small Displacements. B. F. Langer, Review of Scientific Instruments, June 1931, pages 336-342.

An instrument is described which measures and records small displacements such as vibrations and strains from dynamic loads. The results of some recent development work on this instrument are given. (2.01)

The Repetition Theodolite of C. Zeiss. (Der Repitionstheodolit von C. Zeiss.) P. Werkmeister, Zeitschrift fuer Instrumentenkunde, Vol. 51, Feb. 1931, pages 106-107.

Attention is called to the latest design brought on the market by the C. Zeiss Co. E.F. (2.01)

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Leading Instrument Lines Merge

The Pyrometer Division of the Wilson-Maeulen Company, Inc., has merged with The Foxboro Company. This action has followed 25 years of close and friendly co-operation between the two companies, and was made wholly in the interest of better service by thus being able to offer complete instrumentation to industry. The many users of Wilson-Maeulen pyrometers will be served by a larger, more wide-spread group of instrument engineers.

The entire personnel of the Pyrometer Division of Wilson-Maeulen Company will be merged with that of The Foxboro Company. It is felt that this combining of the knowledge and experience of these two organizations will prove an important step in the progress of this industry.

This merger has a significance beyond that of greater facilities. The Wilson-Maeulen Company specializes in the manufacture of electric indicating, recording, and controlling pyrometers and electric resistance thermometers for temperatures up to 3600° F. Thus, by including the outstanding Wilson-Maeulen temperature instruments, The Foxboro Company can now offer a complete range of instruments of standardized quality.

The Rockwell Hardness Tester that has been manufactured by the Wilson-Maeulen Company will hereafter be built and sold by the Wilson Mechanical Instrument Company which succeeds the Mechanical Instrument Division of Wilson-Maeulen Company, Inc., and continues in the same factory and offices at 383 Concord Ave., New York City. The Wilson-Maeulen pyromcters and controllers will be built in the excellently equipped factories at Foxboro.

"Let's Build One Ourselves"

(Continued from Page 5)

niceties, essential for industrial or routine use, are elusive, and invariably costly to obtain the first time. Eventually they are obtained, if the management is sufficiently patient, and at that time, if only the cost of materials finally used is considered, an economy has been effected. Total costs may tell a different story.

Total costs are most apparent when some outside consultant is employed to design and build the instrument, for he is in a position to do the necessary costly work and to cover his expenses for the job. The resultant product is usually a suitable instrument, probably as good as one that might be obtained from some instrument manufacturer. The cost will probably be higher.

Let us consider the accompanying reproductions of advertisements that appeared in the same issue of one of our leading trade papers. Both picture instruments for testing bearing noises, and both give reasonably accurate explanations of the work accomplished by the instruments. A close examination of the instruments shown reveals a striking similarity in design. The two advertisements, and the two instruments, are alike in their essential details. One instrument was built by a specialist who knew his costs and covered them in his price, the other was made by an instrument concern supplying the entire industry and consequently spreading development costs over many sales. One cost $8,500, the other $750. In neither case was there an undue profit; the difference lies entirely in the charge per instrument sold for the cost of development. And yet, where vacuum tubes are used in instrument construction, every engineer is tempted to build his own.

Every week, the management of some corporation decides, "Let's build one ourselves," and every week, with few exceptions, some other management decides to stop the expenditure for instrument development which originally looked simple. The false economy of designing and building one's own instruments becomes evident and is remembered until a new need arises, a new engineer believes that he can build something to fulfill the needs, and again the management decides, "Let's build one ourselves."

◆◆◆◆◆

Numbered among the newest of firms to invade the precision and electrical instrument field is the Industrial Jewel Company, Inc., of Waltham, Mass.

The company is owned and operated by a group of long experience in the jewel bearing industry, many of the workers having spent a lifetime in this line of endeavor. It is the intention of the company not only to furnish jewels and jewel bearings to present users but to develop new uses for their product. An experimental staff will be maintained to assist product engineers and designers with their problems. The most modern equipment and approved methods of manufacture will be employed in their plant.

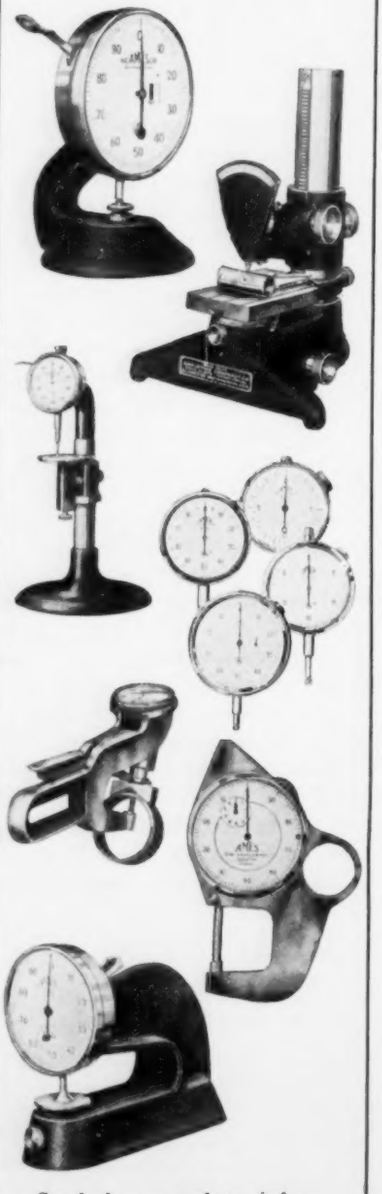
◆◆◆◆◆

Harry J. Hosking has resigned his position in the research laboratory of the Roessler and Hasslacher Chemical Co., at Niagara Falls, N. Y., to take up similar work with Foster D. Snell, Inc., 130 Clinton St., Brooklyn, N. Y.

AMES GAUGES

for every purpose

MEASURING
TESTING
COMPARING



Send for complete information on the extensive line of Ames Dial Gauges.

B. C. AMES CO.
WALTHAM, MASS.
901 Stephenson Bldg., Detroit

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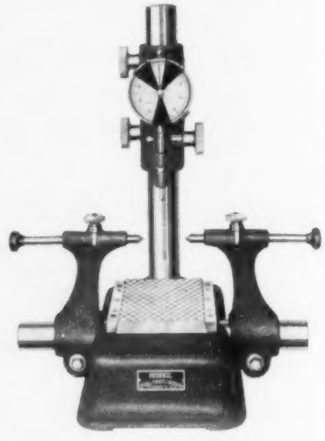
FEDERAL

PRECISION MEASURING INSTRUMENTS
AND
DIAL INDICATORS



FEDERAL PRODUCTS CORP.
PROVIDENCE, R. I.
CHICAGO · CLEVELAND · DETROIT
NEW YORK · MUNCIE, IND.

P·Y·R·O PYROMETERS

RADIATION

Portable. Sight into furnace or at the material, and within 3 seconds you have automatically a true temperature indication.

Stock ranges: 1000-2600°F; 1400-3600°F.

OPTICAL

The only self-contained, direct reading Pyrometer. Concentrated test mark permits precision temperature readings of minute spots.

Stock ranges: 1400-2400°F; 1800-3300°F; 1400/2200°F and 1900/3400°F.

TUBES—Radiation

Standard or Super-Sensitive. Proven economical as compared with thermocouples when measuring high temperatures. Super-Sensitive Tubes have time lag of approximately 1 second.

RAPID RECORDER

Novel construction permits instant and continuous recording.

WRITE FOR BULLETINS

THE PYROMETER INSTRUMENT CO.
103 Lafayette Street New York

An Improved . . . *Tycos* Self-Acting Regulator

THE Tycos Self-Acting Temperature Regulator is an ideal instrument for inexpensive control, particularly where compressed air is not available and the cost of a compressor is not warranted.

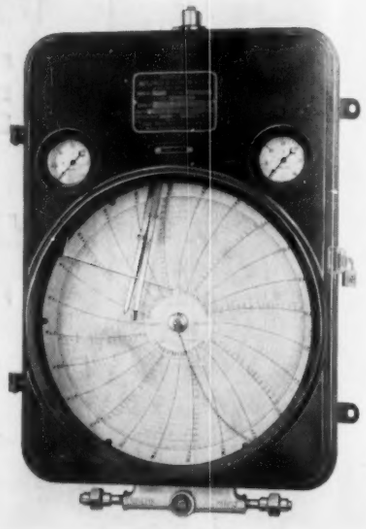
Several important improvements make the Tycos Self-Acting Regulator a very superior instrument of its type. It has a predetermined desirable sensitivity which is substantially uniform for all ranges. The speed of action, safety overload and sturdy construction are features of this outstanding control instrument.

Control points are changed easily and quickly by adjusting nut "A." Scale "B" is useful when resetting the regulator.

This Tycos Self-Acting Temperature Regulator finds use in hundreds of process industries. Write, telling us the application or field in which you are interested and we will send full information, sizes and prices.

Taylor Instruments
ROCHESTER, N.Y., U.S.A.
TAYLOR INSTRUMENT COMPANIES OF CANADA, LIMITED
TORONTO • IN GREAT BRITAIN, MFG. DISTRIBUTORS
TAYLOR-MASON (1940) LIMITED LONDON, E.C.1

BRISTOL'S New Full Floating Recorder Controller gives temperature control *without distortion...*

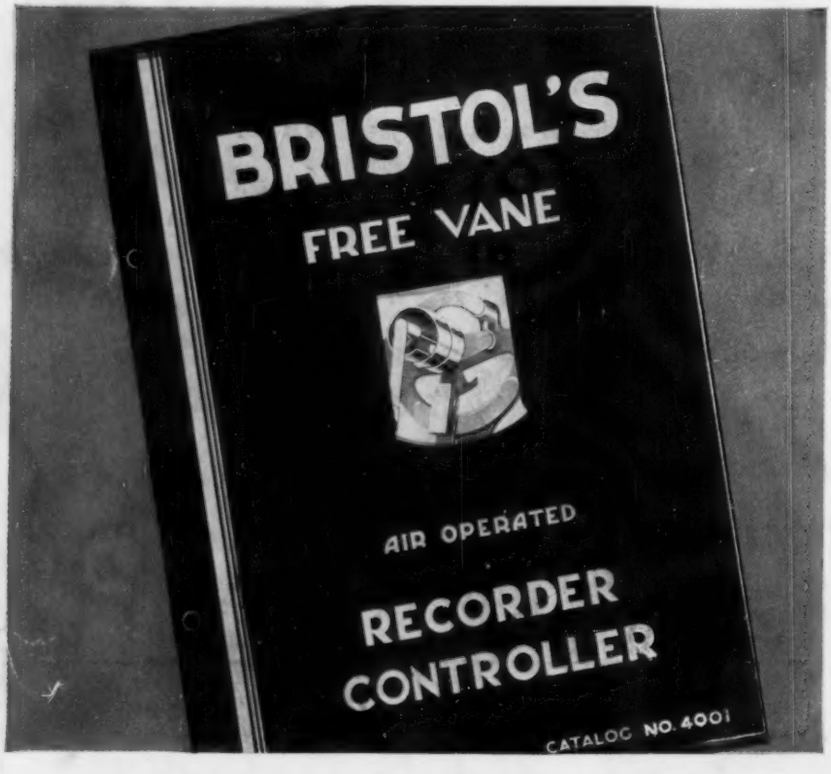


Employs a revolutionary principle of operation —a *Free Vane* Floating between twin air jets

BRISTOL now brings un-thought-of accuracy to the regulation of the temperatures of industrial processes. Distortion and restraint are eliminated by a revolutionary principle of operation, developed by BRISTOL engineers for the new *Free Vane* Recorder Controller.

In this new BRISTOL instrument, control is effected by an ingenious *Free Vane* device which actually floats from one position to another under the influence of temperature fluctuations. Floating between twin air jets, this *Free Vane* does no mechanical work. It encounters no resistance or friction. And it does not interfere with the motion of the recording element to which it is attached. Temperature indications accurately tell the state of the process under control. There is no distortion or restraint, either at, above, or below the control temperature.

The *Free Vane* Recorder Controller gives precisely the control which the temperature record indicates. It incorporates BRISTOL'S perfected sensitive actuating element of the popular helical tube type, which has been accepted by industry as the standard of accuracy.



Get all details—use coupon below

Full information on this remarkable new instrument is given in the 24 page illustrated Catalog No. 4001 shown here. It warrants careful reading by every industrial engineer. Send for your copy NOW. The coupon below brings it to your desk.

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THE BRISTOL COMPANY
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